United States
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Appraisal 1980

Soil and Water Resources
Conservation Act

Review Draft
Part I

SOIL AND WATER RESOURCES
CONSERVATION ACT

1980 Appraisal
Review Draft
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UNITED STATES DEPARTMENT OF AGRICULTURE

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PART I - INTRODUCTION

INTRODUCTION

In 1977, Congress passed the Soil and Water Resources Conservation Act (RCA). This Act directs the Secretary of Agriculture to conduct a continuing appraisal of the status and condition of our soil, water, and related resources. The Department of Agriculture has prepared the first appraisal in two parts. This report is Part I of the 1980 Appraisal. Part II is published separately. The Department will prepare the next appraisal in 1985.

This report analyzes the status and condition of soil resources, water resources, and related resources--wetlands, riparian vegetation, fish and wildlife habitat, windbreaks, organic residues, and recreation. The information on the quantity and quality of these resources is supplemented with statistical data on land and water, land capability, dominant soil conditions, and major uses of nonfederal land.

Part I of the 1980 Appraisal also contains an inventory of legislation and regulations dealing with resources and discusses the impact of technology on agricultural production and conservation. In addition, it identifies resource areas that concern the public and compares these concerns with available data on conservation problems.

Part II of the 1980 Appraisal will present the projected demands on the Nation's soil, water, and related resources up to the year 2030. It will describe the assumptions and analytical methods used to forecast these demands. A major chapter will describe the inherent capabilities and limitations of our resources in responding to projected demands. This chapter will also suggest alternative levels of management that can be used to preserve our resources.

Part II will also provide data on trends in rural land ownership and describe the contributions of state and local programs to soil and water conservation. It will document the data base for the 1980 reports and discuss plans for appraising soil and water resources for the 1985 reports.

The Department of Agriculture can use the 1980 Appraisal as a basis for evaluating its soil and water conservation programs and policies. This evaluation will enable USDA to institute better management and planning that will help the Nation maintain a high quality and productive supply of natural resources.

Chapter 1 - Summary and Highlights

There is an enormous variety of soils in the United States. Over 12,000 soil series have been recognized and each has a different set of properties. The largest acreages of high quality soils are in the Corn Belt, the Lake States, the Northern Plains, and the Delta States. Chapter 2 discusses soils and other land resources.

Changing land use patterns have important effects on the status and condition of our Nation's resources. The United States has a significant net loss in cropland every year. The acreage of forest land is also decreasing. However, the size of the Nation's grazing land has been increasing slowly since 1958. Urban, built-up, and transportation land increased 86 percent between 1958 and 1977. Forty-four million acres of land, much of it cropland, were lost to these land uses.

The land managed for certain uses is not meeting its full potential. For example, the nearly 377 million acres of nonfederal forest land are producing timber at well below their biological potential.

The acreage of land that has been used for surface mining is a small percentage of our total land area. However, the intense hydrologic and esthetic changes in the environment caused by mining make it a land use of great concern to Americans. Chapter 3 describes the various land uses and associated problems.

One hundred and thirty-five million acres of noncropland in the United States could be converted to cropland. It would require considerable investment to convert 95 million acres of this land. Only 70 million acres of the convertible land is considered prime farmland. Chapter 4 discusses prime farmland and potential cropland.

An average of 337 billion gallons of water per day is withdrawn from surface supplies and pumped from the ground in the United States. Four times more water is used to produce food and fiber than for all other purposes combined. Irrigated crops account for about 25 percent of the total value of our crop production.

Water shortages have been identified in 70 percent of the Nation's hydrologic regions. Ground water withdrawals in excess of natural recharge occur at the rate of 21 billion gallons per day nationally. Water supply, quality, and use are discussed in chapter 5, Water Resources.

Basic resources such as soil and water are not our only resources. The well-being of our related resources--wildlife, wetlands, recreation, and others--is closely linked to the condition, status, and use of our basic resources. Wetlands, our most productive wildlife land, continue their historic downward trend with an average annual loss of 318,000 acres. Water quality appears to be improving, but in the face of increasing use and demands on stream water, it may be difficult to meet the minimun streamflows required by fish and wildlife. Wildlife habitat on cropland continues to diminish because of many interrelated factors, mainly changes in farming methods and equipment. These changes reduce the quantity and diversity of habitat needed by wildlife.

Related resources are presently meeting or could meet many of the Nation's needs. Livestock convert the inedible resources on half of our lands to edible foods and constitute a major food supply. Recreation is an important and growing use of land and water. Farm ponds provide 11 percent of the warm water fishing in the Nation. Aquaculture is a related resource with significant potential. It is a growing industry, currently built around production of catfish, trout, bait, and crawfish, that could eventually reduce the Nation's $2.6 billion foreign trade deficit in fish products. Chapter 6 discusses the related resources and their relationship to the basic resources.

The term scenic rural landscapes conjures up images of manor houses surrounded by rolling green hills and white fences, an infinite sea of golden wheat fields, or endless rows of cotton parched by the southern sun. The present reality of America's rural scenery no longer matches these pastoral images. America's countryside is becoming industrialized. The rural landscape covers about 2.3 billion acres and, because it is largely privately owned, its scenic resources are not protected from unrestrained development.

Modern agricultural technology is changing the appearance of the American farm. Traditional farmsteads are becoming industrialized operations with complex machinery, storage facilities, and feedlots. Since the American Revolution, technology has increasingly affected agricultural production and conservation--with both positive and negative results. For example, large equipment promotes the enlargement of fields to make production more efficient. On the other hand, the use of this equipment may adversely affect wildlife habitat and accelerate erosion. The push toward ever greater production can bring about farming of soils with marginal capability. America's rural landscape and man's effects upon it are discussed in chapter 7. The impact of technology is considered in chapter 12.

Eighteenth and nineteenth century settlers followed a farm-out and move-on philosophy until homesteading on new lands in the West ended with World War I. Americans paid little attention to erosion until a soil surveyor named Hugh Hammond Bennett published "Soil Erosion, a National Menace," in April 1928 (USDA Circular 33). This publication stirred the Congress and the Department of Agriculture into action. The history of the soil and water conservation movement is related in chapter 11. The federal, state, and local laws that were spawned by this movement are covered in chapters 8, 9, and 10.

The Resources Conservation Act requires that the public be given the opportunity to participate in appraising the status and condition of our soil, water, and related resources. The chief concerns at the RCA public meetings were soil erosion, food and fiber production, land use, water supply, and water quality, in that order. In chapter 14, the public's concerns are correlated with selected resource data.

PART II - THE STATUS, CONDITION, AND TREND OF SOIL, WATER, AND RELATED RESOURCES

Chapter 2 - Soil Resources

Section A-Soil Quantity

Land Use

The total surface area of the United States is about 2.36 billion acres (table 2A-1). Of this total, about two-thirds of our land (1.5 billion acres) is owned in individual parcels by private citizens, by business and industry, and by states, counties, cities, and other units of nonfederal government. One-third (752 million acres) is administered by the federal government in the public interest. About 99 million acres are large water areas more than 40 acres in size and streams more than one-eighth mile wide. Nearly all the cropland, pastureland, and native pasture is under nonfederal ownership.

In 1977, the 1.5 billion acres of nonfederal land and small water bodies in the United States and the Caribbean area were 27 percent cropland (413 million acres), 9 percent pastureland and native pasture (134 million acres), 27 percent rangeland (414 million acres), 25 percent forest land (377 million acres), and 12 percent urban and built-up areas, roads and highways, areas of open water of less than 40 acres, and streams less than one-eighth mile wide (175 million acres). See figure 2A-1.

Table 2A-2 gives a summary of land use of nonfederal, rural land in 1977 by state. It excludes urban and built-up areas of more than 10 acres.

Land Use and Land Capability

Land use in the United States conforms in general to land capability. The land capability classification system groups soils on the basis of their ability to produce common cultivated crops and pasture plants without deterioration. Definitions of the land capability classes are in the glossary.

In 1977, land in capability classes I, II, and III was used mainly for cropland. Land in classes IV, V, VI, and VII was used mainly for pasture, range, and forest (figure 2A-2). Excluding Alaska, 82 percent of nonfederal, rural class I land, 65 percent of class II, 46 percent of class III, and 23 percent of class IV land was cropland.

Trends in Land Use

Use of the Nation's nonfederal land is changing. The acreage of cropland and forest land is decreasing. The acreage of pastureland, native pasture, and rangeland is increasing. The acreage of urban, built-up, and transportation land is increasing at a growing rate. These changes are discussed in greater detail by land use.

Cropland.--The acreage of nonfederal land used for cropland in the United States has decreased steadily in the past 20 years. In the period 1958 to 1967, there was an 11 million-acre decrease in cropland--from 449 million acres to 438 million acres--which is slightly more than 1 million acres per year. In the period 1967 to 1977, there was a 25 million-acre decrease in

Table 2A-1.--Land and water in the United States and Caribbean Area in 1977 1/

Type of surface area	Millions of acres
Land	
Nonfederal	
Forest land	377
Rangeland	414
Cropland	413
Pastureland and native pasture	134
Other (includes 9 million acres of small water) 2/	175
Total nonfederal land	1,513
Federal	
Forest	285
Range	439
Other	28
Total federal land	752
Total land area	2,265
Water 2/	
Large water bodies	51 3/
Coastal and boundary water	48 4/
Total water area	99
Total land and water area	2,364

1/ Data sources: Nonfederal data are from 1977 National Resource Inventories. SCS adjusted county base data from 1970 Bureau of Census data. Includes the 50 states plus the Caribbean area.

2/ Small water bodies are streams and rivers less than 1/8 mile wide and other water bodies less than 40 acres in size. Small water bodies are not counted as water by the Census Bureau. Their acreage is included with land in this table.

3/ Large water bodies (counted as water by the Census Bureau) are lakes and reservoirs more than 40 acres in size and streams and rivers more than 1/8 mile wide.

4/ Includes Great Lakes and large estuaries.

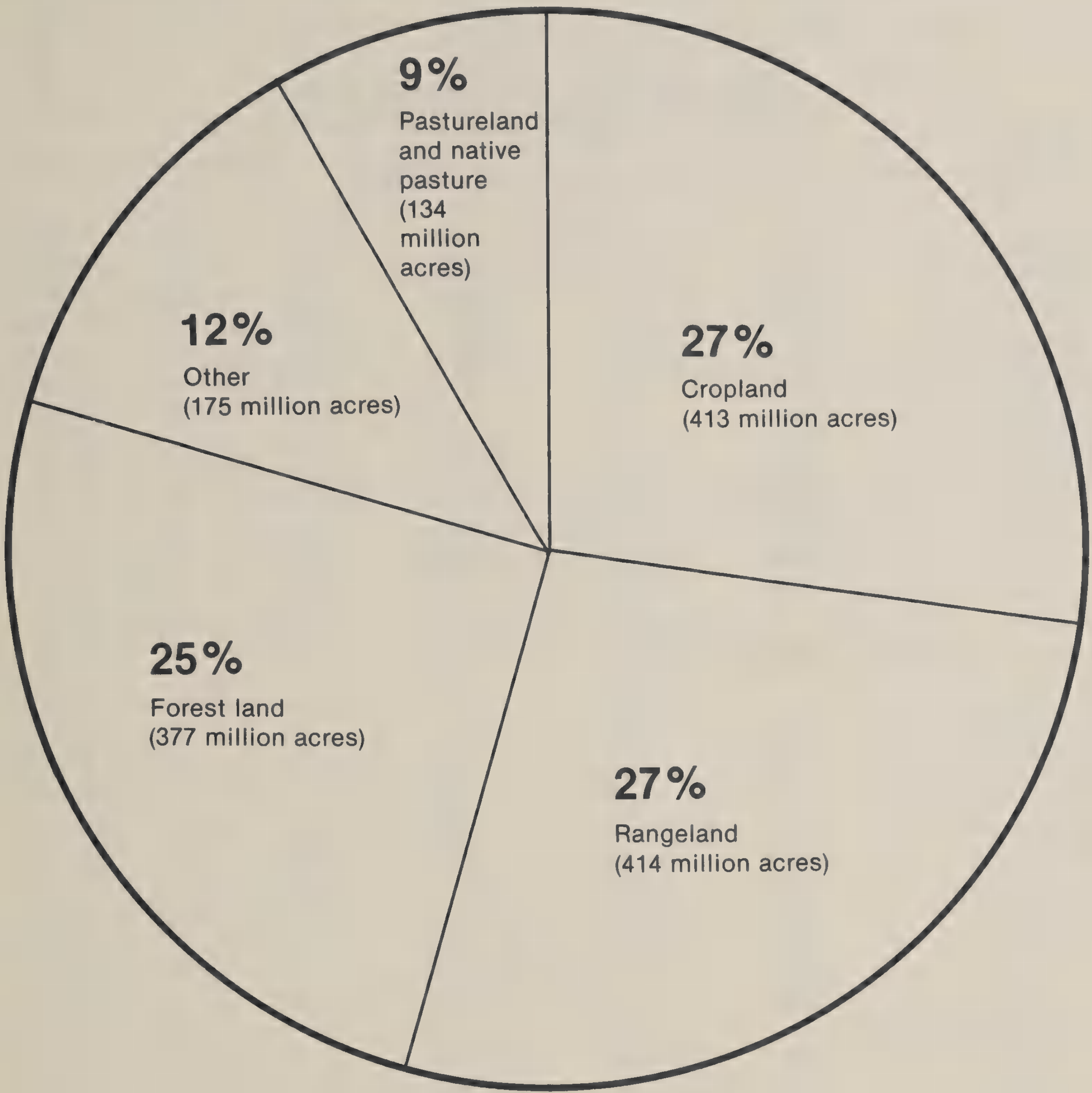


Figure 2A-1.--Use of nonfederal land in the United States and the Caribbean, 1977.

Table 2A-2.--Rural nonfederal land in 1977, by state

State	Cropland Irr.	Cropland Nonirr.	Pasture, native pasture & rangeland	Forest land	Other	Total
			(1,000 acres)			
Alabama---------	35	4,451	4,120	19,792	1,546	29,944
Arizona---------	1,276	35	35,103	1,804	1,610	39,828
Arkansas--------	2,465	5,526	5,874	14,069	1,322	29,256
California------	8,355	1,738	18,688	9,857	11,077	49,715
Colorado--------	3,487	7,601	25,403	3,343	2,194	42,028
Connecticut-----	8	199	113	1,418	459	2,197
Delaware--------	34	497	22	360	154	1,067
Florida---------	1,733	1,457	8,498	12,146	3,928	27,762
Georgia---------	636	5,848	3,232	21,567	1,921	33,204
Hawaii----------	150	140	990	1,443	907	3,630
Idaho-----------	3,617	2,664	7,700	4,229	872	19,082
Illinois--------	66	23,753	3,068	3,026	2,721	32,634
Indiana---------	139	13,173	2,148	3,533	1,950	20,943
Iowa------------	73	26,337	4,527	1,483	2,424	34,844
Kansas----------	3,331	25,477	18,975	786	2,444	51,013
Kentucky--------	10	5,431	5,734	10,645	1,345	23,165
Louisiana-------	1,161	4,741	3,271	12,594	5,000	26,767
Maine-----------	23	887	249	16,520	1,664	19,343
Maryland--------	40	1,644	480	2,160	745	5,069
Massachusetts---	18	266	92	2,756	676	3,808
Michigan--------	232	9,227	1,226	15,322	4,288	30,295
Minnesota-------	400	22,533	2,999	13,807	6,451	46,190
Mississippi-----	353	6,940	4,070	14,416	1,573	27,352
Missouri--------	788	13,776	12,858	10,829	2,476	40,727
Montana---------	2,262	13,096	41,484	6,343	2,415	65,600
Nebraska--------	6,908	13,758	24,896	439	1,803	47,804
Nevada----------	1,112	0	7,648	229	1,421	10,410
New Hampshire---	0	271	93	3,976	462	4,802
New Jersey------	153	628	145	1,967	656	3,549
New Mexico------	1,440	835	42,481	3,426	2,473	50,655
New York--------	79	5,879	2,282	15,445	3,943	27,628
North Carolina--	277	5,903	2,025	16,818	2,255	27,278
North Dakota----	77	26,857	12,113	368	2,938	42,353
Ohio------------	49	11,700	2,614	5,860	2,309	22,532
Oklahoma--------	727	11,077	23,285	4,933	1,779	41,801
Oregon----------	2,071	3,074	11,875	10,062	1,344	28,426
Pennsylvania----	10	5,641	1,797	14,349	3,265	25,062
Rhode Island----	0	26	15	303	83	427
South Carolina--	45	3,297	1,242	10,770	1,391	16,745
South Dakota----	474	17,671	24,611	333	2,441	45,530
Tennessee-------	26	4,894	5,473	11,639	1,569	23,601
Texas-----------	8,284	22,146	114,174	9,240	6,050	159,894
Utah------------	1,250	565	9,989	1,066	3,158	16,028

Table 2A-2.--Rural nonfederal land in 1977, by state--Continued

State	Cropland Irr.	Cropland Nonirr.	Pasture, native pasture & rangeland	Forest land	Other	Total
			(1,000 acres)			
Vermont---------	7	596	540	3,931	336	5,410
Virginia--------	83	3,127	3,276	13,237	1,487	21,210
Washington------	1,835	6,115	7,292	12,413	1,410	29,065
West Virginia---	10	984	2,039	9,805	772	13,610
Wisconsin-------	340	11,407	2,746	13,252	3,980	31,725
Wyoming---------	1,652	1,315	26,904	1,163	1,397	32,431
Caribbean-------	46	317	927	428	143	1,861
Alaska 1/-------	NA	NA	6,276	6,900	NA	13,176
Total------	57,647	355,520	547,682	376,600	111,027	1,448,476

1/ USDA. 1978. Forest Statistics of the U.S., 1977.
NA = Data not available.
Source: 1977 National Resource Inventories

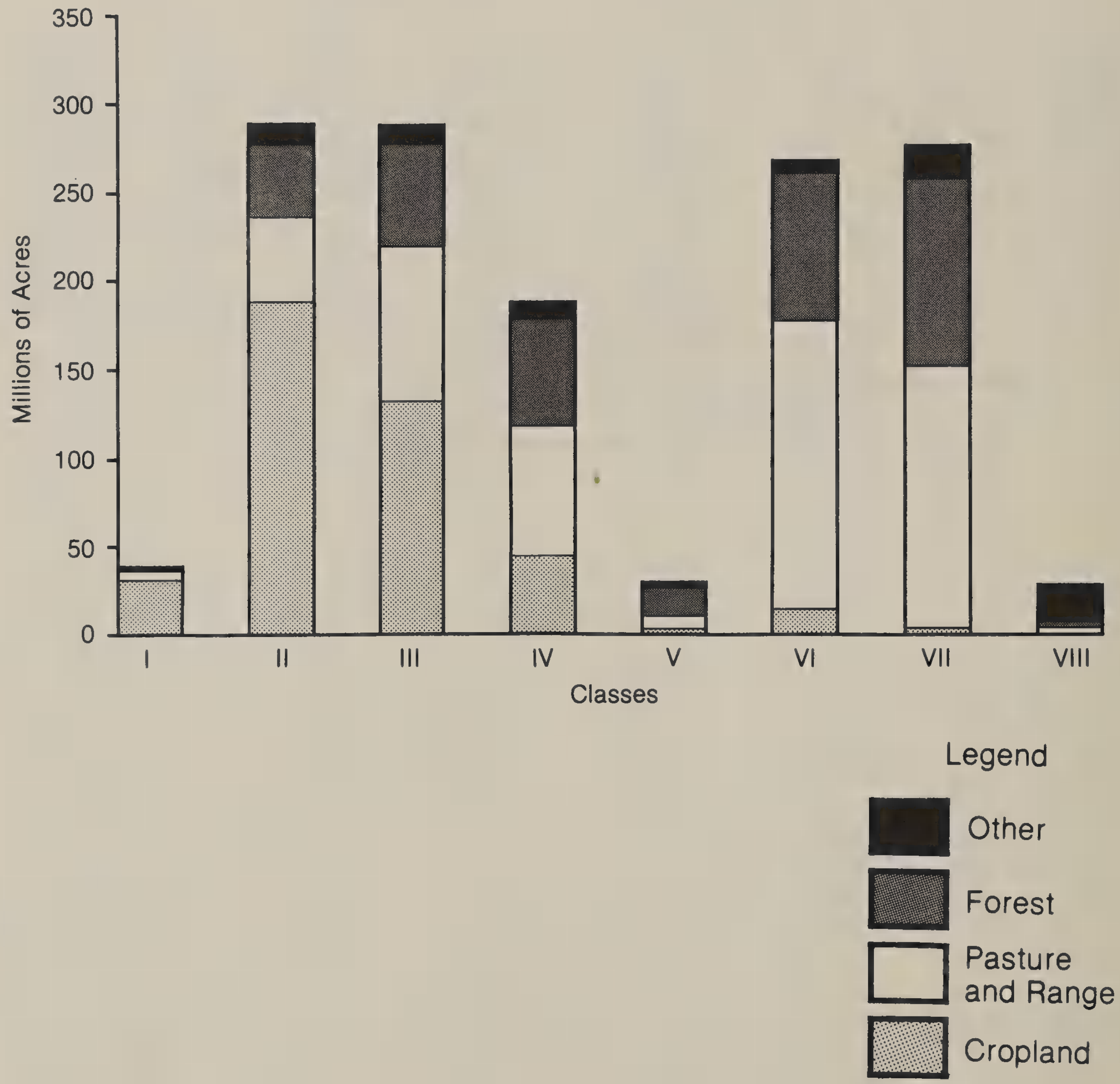


Figure 2A-2.--Land capability and land use, 1977.

cropland--from 438 million acres to 413 million acres--which represents a decrease of 2.5 million acres per year. See table 2A-3. This decrease, however, has slowed in the past few years and the total cropland acreage has remained relatively constant. The acreage of cropland irrigated has greatly increased. In 1958, 37 million acres were irrigated. By 1967, 44 million acres were irrigated, and by 1977, 58 million acres of cropland were under irrigation. This is an increase of 21 million acres of irrigated cropland in 19 years. The rate of cropland added to irrigation accelerated from .8 million acres per year from 1958 to 1967 to 1.4 million acres a year from 1967 to 1977.

The Potential Cropland Study (USDA, 1977) shows that the acres of cropland today are not necessarily the same acres that were cropped in previous years. Cropland shifts in and out of production -- its major shift is with pasture. Between 1967 and 1975, 53 million acres shifted from cropland to pasture and 32 million acres shifted from pasture to cropland (figure 2A-3). During the same period, 11 million acres shifted from forest land to cropland and 8 million acres shifted from cropland to forest land. Approximately 13 million acres shifted from cropland to idle land or rural residences and 6 million acres shifted from idle land to cropland. A total of 5 million acres shifted from cropland to water or urban uses in that 8-year period.

Pastureland, Native Pasture, and Rangeland.--The acreage of grazing land increased from 486 million acres in 1958 to 548 million acres in 1977 (see table 2A-3). Most of the change occurred in the last 10 years. Part of this change is the result of a redefinition of rangeland and forest land. In 1977, transitional ecosystems, such as brush, pinyon juniper, and mesquite, were included in rangeland. In the 1958 and 1967 data they were included with forest land. Even with these differences, the trend is correct, and more land is now available for grazing.

The Potential Cropland Study (USDA, 1977) shows that from 1967 to 1975, pasture and rangeland increased at the expense of forest land (62 million acres) and cropland (53 million acres). At the same time, 14 million acres of pasture and rangeland were converted to forest land and 32 million acres to cropland (figure 2A-3).

Forest Land.--Nonfederal forest land decreased from 453 million acres in 1958 to 377 million acres in 1977. A part of this change is caused by the redefinition of forest land between the different reporting dates. The overall decline of nonfederal forest land, however, appears to express the correct trend.

The Potential Cropland Study (USDA, 1977) shows that from 1967 to 1975, 62 million acres of forest land were converted to pastureland and rangeland, about 11 million acres to cropland, 7 million acres to water and urban built-up uses, and about 16 million acres to other uses. At the same time, 14 million acres of pasture and rangeland, 4 million acres of idle land, and 8 million acres of cropland were converted to forest land (figure 2A-3).

Urban Land.--Residences, factories, shopping centers, and roads are absorbing land at an increasing rate. During the period 1958 to 1967, about 10 million acres of rural land were converted to urban, built-up, and transportation uses. This amounts to slightly more than 1 million acres per year. In the

Table 2A-3.--Trends in the use of nonfederal land, 1958, 1967, and 1977 1/

50 states and the Caribbean Area
(millions of acres)

	1958 2/	1967 3/	1977 4/
Cropland---------------------	449	438	413
Irrigated---------------	37	44	58
Nonirrigated------------	412	394	356
Pastureland, native pasture, and rangeland--------------	486	483	548
Pastureland and native pasture----------------	NA 5/	102	134
Rangeland----------------	NA	380	414
Forest land------------------	453	463	377
Urban land (over 10 acres)---	51	61	90
Small areas of open water----	7	7	9 6/
Other------------------------	67	57	76 7/
Total------------------	1,513	1,509	1,513

1/ Some land use definitions have changed slightly from one inventory to another. See individual source document for the land use definitions in effect at the time of inventory.

2/ Data from basic statistics of the National Inventory of Soil and Water Conservation Needs, 1958.

3/ Data from basic statistics of the National Inventory of Soil and Water Conservation Needs, 1967.

4/ Data from SCS National Resource Inventories, 1977, adjusted to include Alaska.

5/ NA means no data available.

6/ 1977 data include 1 million acres of water bodies covering less than 2 acres.

7/ 1977 data include 4 million acres of built-up land between 0.25 and 10.0 acres in size.

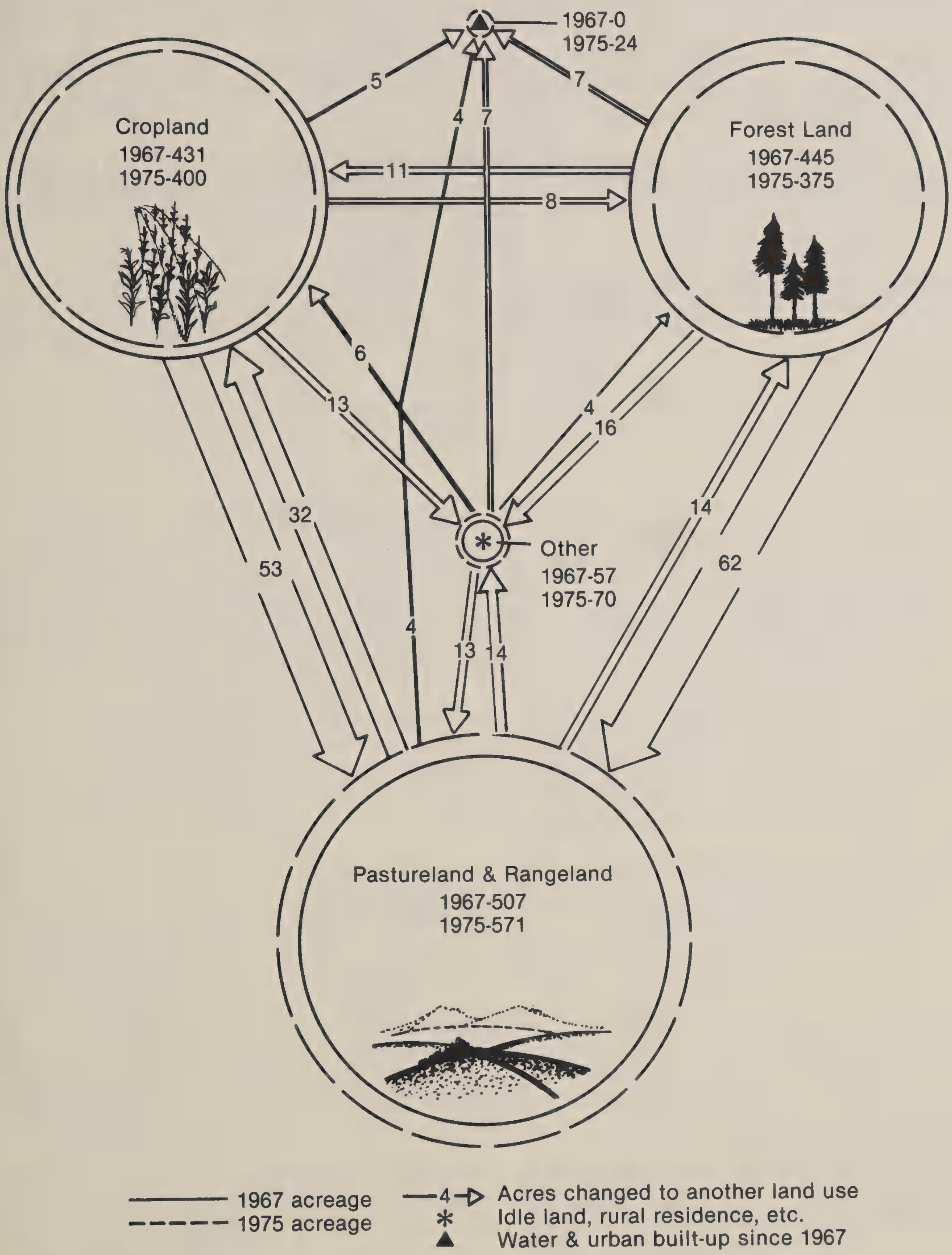


Figure 2A-3.--Land use conversions between 1967 and 1975 (millions of acres).

period 1967 to 1977, about 29 million acres of rural land were converted to urban, built-up, and transportation uses. This is 2.9 million acres per year, nearly 3 times the rate during the previous 9-year period (table 2A-3).

Schmude (1977) shows that of the 23 million acres converted from rural land to urban and water uses between 1967 and 1975, more than one-third (8 million acres) was prime farmland.

The Potential Cropland Study (USDA, 1977) shows that from 1967 to 1975, water and land for urban and built-up uses came from forest land, cropland, pastureland and rangeland, and other land (including idle land and rural residence) in about equal amounts (figure 2A-3).

Each acre taken by development usually means that at least 1 more acre is isolated and lost from farm production (Dideriksen and Sampson, 1976).

Section B-Soil Quality

The soils of the United States range from continually wet to continually dry, from sandy to clayey, from acid to alkaline, and from shallow to deep. They also vary in slope, porosity, organic content, temperature, and the capacity to supply nutrients. They are classified according to these and other properties in order to better understand how they respond to different uses. Soil surveys show the amount and location of soils with different properties. More than 12,000 different kinds of soil (soil series) have been recognized, each of which covers an area from a few thousand acres up to a few million acres.

Soil surveys of counties or similar size areas show the location and extent of these soils. They give information on the physical and chemical properties of the soils and their potential and limitations for various uses and management. The information is useful in making decisions on the use and management of soils for crops, pasture, range, and forest, as well as for many nonfarm uses such as building sites, sanitary facilities, construction materials, and recreation developments. Soil surveys are completed for about 65 percent of the United States, and detailed information is available in nearly every county.

Figure 2B-1 is a map that generalizes the detailed information on soils to provide a broad perspective on the soils and landscapes of the country (USDA, 1975). This map is a simplified version of the General Soil Map of the United States compiled in 1967 that appears in the National Atlas of the United States (USDI, 1970). Each of the 59 units on the map indicates a group of soils that have certain similarities and definable characteristics. These groups are soil orders and suborders. (See glossary.)

Table 2B-1 shows the approximate acreage and extent of soil orders and suborders in the United States and relates them to the mapping units used in figure 2B-1. It also lists the dominant soil properties, land use, and soil and water problems. For more detailed information on soils within the mapping units, refer to Chapter 20, Soil Taxonomy (USDA, 1975).

The information given in table 2B-1 is based on only the principal kinds of soil that are named for each mapping unit on the General Soil Map of the United States (figure 2B-1) (USDA, 1975). Many kinds of soil cannot be named at this scale. Therefore, the conditions, uses, and problems cannot be applied to areas as specific as parts of states or counties.

Each of the many kinds of soils is of good quality for some particular use--for growing soybeans, for foundations for roads or buildings, or for wildlife habitat. Each soil can be rated in terms of its quality for certain uses. A soil that is good for crops may be fair for road foundations and poor for wetland wildlife habitat.

Soils can be classified in a number of ways. The land capability classification system (see glossary) is the common expression of the quality of soils for producing food and fiber. Land capability classes and subclasses

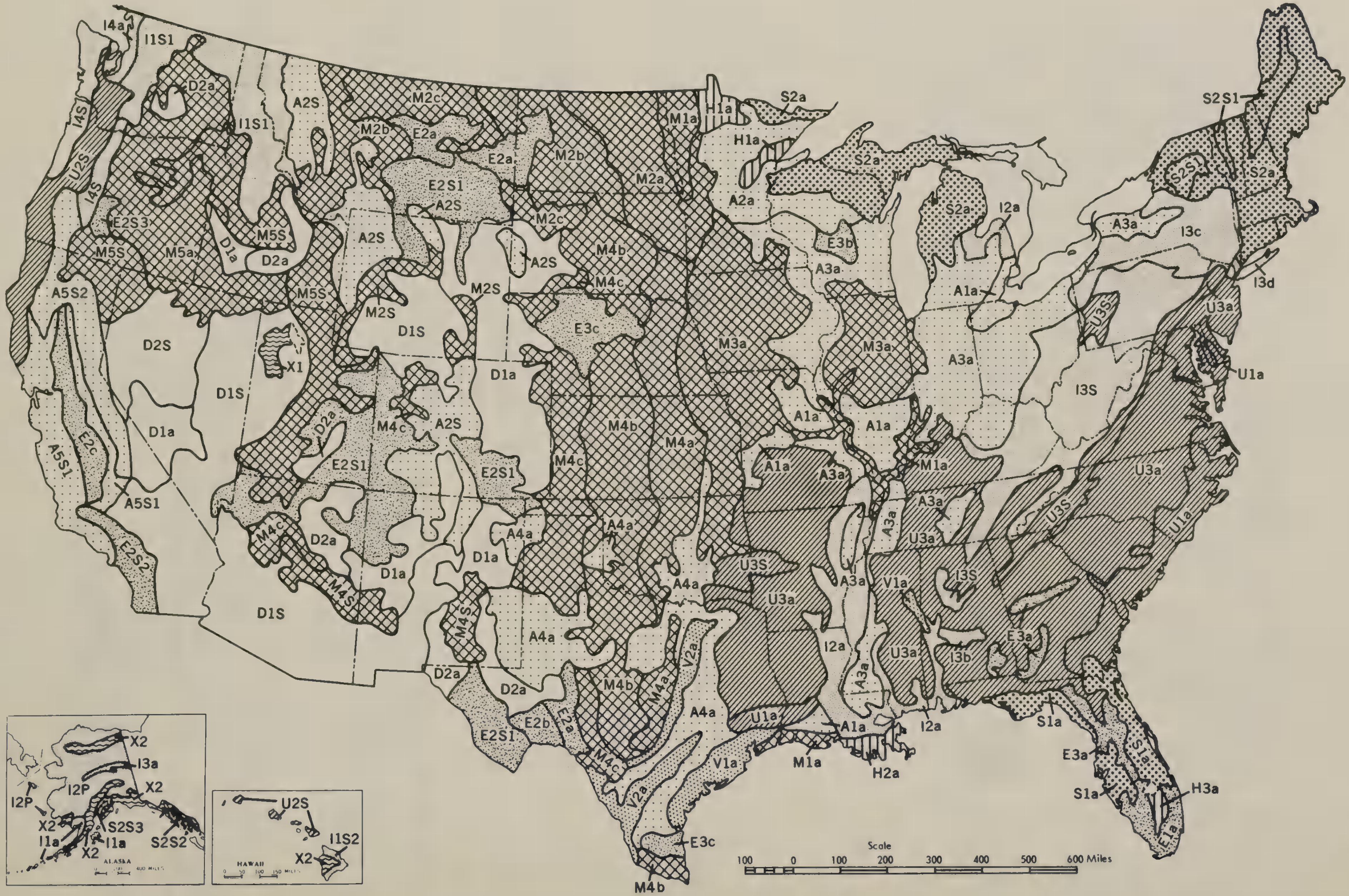


Figure 2B-1.--General soils map.

Table 2B-1.--Soil properties, land use, and management problems for soils of the United States (continued)

SOIL AND MAP UNIT		AREA (sq mi)	PROPORTION OF COUNTRY (percent)	SOIL FERTILITY 1/	SOIL MOISTURE REGIME 2/	SOIL TEMPERATURE REGIME 3/	SLOPES 4/	LAND USE & PRINCIPAL CROPS	PROBLEMS IN MANAGEMENT
Entisols		284250	7.9						
Aquents	E1a	8200	0.2	moderate and low	aquic	hyperthermic	gentle	wetland cropland row crops, pasture	wetness flooding
Orthents	E2a	188450	5.2	low and moderate	aridic	frigid	steep	rangeland	dryness steepness
	E2b			low and moderate	aridic	thermic	gentle and moderate	rangeland	dryness depth to rock
	E2c			moderate	xeric	thermic	gentle	cropland row crops, small grains, forage	drought erosion
	E2S1			low and moderate	aridic	mesic	steep	rangeland	dryness stoniness steepness depth to rock
	E2S2			low	xeric	thermic	steep	forest, rangeland	steepness drought stoniness
	E2S3			low and moderate	xeric	cryic	gentle, moderate, and steep	forest	drought steepness short growing season
Psamments	E3a E3b E3c	76850	2.2	low	udic, ustic and xeric	mesic, thermic, & hyperthermic	gentle and moderate	cropland row crops, rangeland	low available moisture low inherent fertility erosion
Histosols	H1a H2a H3a	18750	0.5	moderate and high	aquic	cryic, mesic, thermic, hyperthermic	gentle	wetland forest land cropland row crops	wetness flooding subsidence
Inceptisols		655700	18.2						
Andepts	I1a	66950	1.9	high and moderate	xeric	cryic	gentle and moderate	forest land rangeland	short growing season rock outcrops
	I1S1			high and moderate	xeric	cryic	steep	forest land	shortgrowing season steepness
	I1S2			high and moderate	udic	isothermic, isomesic	moderate and steep	rangeland cropland sugar cane	erosion
Aquepts	I2 I2P	411100	11.4	moderate	aquic	cryic, frigid, mesic, thermic	gentle and moderate	cropland row crops forest land wetland	wetness flooding

Table 2B-1.--Soil properties, land use, and management problems for soils of the United States

SOIL AND	MAP UNIT	AREA (sq mi)	PROPORTION OF COUNTRY (percent)		SOIL FERTILITY 1/	SOIL MOISTURE REGIME 2/	SOIL TEMPERATURE REGIME 3/	SLOPES 4/	LAND USE & PRINCIPAL CROPS	PROBLEMS IN MANAGEMENT
Alfisols		483450	13.4							
Aqualfs	Ala	36400		1.0	high	aquic	mesic, thermic	gentle	cropland row crops, small grains, forage crops, rice	wetness, flooding
Boralfs	A2a	107500		3.0	high	udic	cryic, frigid	gentle and moderate	forest land cropland small grains, forage	short growing season
	A2S				high	udic	cryic	steep	forest land	steepness, shallowness, stoniness
Udalfs	A3a	211550		5.9	high	udic	mesic, thermic	gentle and moderate	cropland small grains, corn, soybeans, row crops	erosion
Ustalfs	A4a	94650		2.6	high	ustic	mesic, thermic	gentle and moderate	cropland small grains rangeland	erosion (water, wind) drought
Xeralfs	A5S1 A5S2	33350		0.9	high	xeric	cryic, mesic, thermic	moderate and steep	rangeland forest land cropland row crops	erosion steepness stoniness drought
Aridisols		414400	11.5							
Argids	Dla D1S	310900		8.6	high	aridic	frigid, mesic, thermic	gentle, moderate and steep	rangeland	dryness salinity erosion slope stoniness
Orthids	D2a D2S	103500		2.9	high	aridic	mesic, thermic	gentle, moderate, and steep	rangeland	dryness salinity erosion slope stoniness

Table 2B-1.--Soil properties, land use, and management problems for soils of the United States (continued)

SOIL AND MAP UNIT		AREA (sq mi)	PROPORTION OF COUNTRY (percent)	SOIL FERTILITY 1/	SOIL MOISTURE REGIME 2/	SOIL TEMPERATURE REGIME 3/	SLOPES 4/	LAND USE & PRINCIPAL CROPS	PROBLEMS IN MANAGEMENT
Ochrepts	I3a	153450	4.3	low	udic	cryic	gentle and moderate	forest land cropland slall grain, forage crops	short growing season erosion
	I3b			moderate and high	udic	thermic	gentle	cropland row crops, pasture	erosion
	I3c			moderate and low	udic	mesic	gently and moderately	forest land cropland row crops	erosion
	I3d			low	udic	mesic	gentle	cropland row crops	erosion
	I3S			low	udic	mesic and thermic	steep	forest land cropland forage crops	erosion steepness stoniness
Umbrepts	I4a I4S	24100	0.7	low	udic, xeric	mesic	gentle moderate, and steep	forest land	steepness
Mollisols		896000	24.6						
Aquolls	M1a	46100	1.3	high	aquic	frigid, mesic, thermic	gentle	cropland row crops, small grain	wetness flooding
Borolls	M2a M2b	176800	4.9	high	udic	cryic, frigid	gentle and moderate	cropland small grains (wheat)	short growing season
	M2c M2S			high	ustic	cryic, frigid	moderate and steep	rangeland	steepness stoniness drought
Udolls	M3a	170450	4.7	high	udic	mesic, thermic	gentle and moderate	cropland row crops, small grains, hay	erosion
Ustolls	M4a M4b	318400	8.8	high	ustic	mesic, thermic	gentle and moderate	cropland small grains rangeland	drought erosion
	M4c M4S			high	ustic	mesic, thermic	moderate and steep	rangeland	erosion depth to rock stoniness drought

Table 2B-1.--Soil properties, land use, and management problems for soils of the United States (continued)

SOIL AND MAP UNIT		AREA (sq mi)	PROPORTION OF COUNTRY (percent)		SOIL FERTILITY 1/	SOIL MOISTURE REGIME 2/	SOIL TEMPERATURE REGIME 3/	SLOPES 4/	LAND USE & PRINCIPAL CROPS	PROBLEMS IN MANAGEMENT
Xerolls	M5a	184250		4.8	high	xeric	mesic	gentle and moderate	cropland row crops, small grains, rangeland	erosion drought
	M5S				high	xeric	mesic	moderate and steep	rangeland	steepness drought
Oxisols (not delineated on map)		500	<0.02							
Spodosols		183050	5.1							
Aquods	Sla	25900		0.7	low	aquic	thermic and hyperthermic	gentle	forest land cropland row crops, pasture	wetness flooding low inherent fertility
Orthods	S2a	157150		4.4	low	udic	frigid, mesic	gentle and moderate	forest land cropland row crops	erosion low inherent fertility
	S2S1				low	udic	frigid, mesic	moderate and steep	forest land	steepness stoniness
	S2S2 S2S3				low	udic	cryic, frigid	gentle to steep	forest land	steepness short growing season stoniness
Ultisols		463050	12.9							
Aquults	Ula	41250		1.1	low and moderate	aquic	mesic, thermic	gentle	forest land cropland row crops	wetness flooding
Humults	U2S	27550		0.8	low and moderate	udic	mesic, isomesic isothermic, isohyperthermic	gentle to steep	forest land cropland row crops (sugar cane)	erosion steepness
Udults	U3a	357650		10.0	low and moderate	udic	mesic, thermic	gentle and moderate	forest land cropland row crops	erosion

Table 2B-1.-- Soil properties, land use, and management problems for soils of the United States (continued)

SOIL AND MAP UNIT		AREA (sq mi)	PROPORTION OF COUNTRY (percent)		SOIL FERTILITY 1/	SOIL MOISTURE REGIME 2/	SOIL TEMPERATURE REGIME 3/	SLOPES 4/	LAND USE & PRINCIPAL CROPS	PROBLEMS IN MANAGEMENT
Udults	U3S				low and moderate	udic	mesic, thermic	moderate and steep	forest land	erosion steepness stoniness
Xerults (not delineated on map)		36600		1.0						
Vertisols		35300	1.0							
Uderts	V1a	13500		0.4	high	udic	thermic	gentle	cropland row crops, grazing, rice	shrink-swell clays slow permeability
Usterts	V2a	21500		0.6	high	ustic	thermic	gentle	cropland row crops rangeland	shrink-swell clays slow permeability
Areas With Little Soil		161000	4.5							
Salt flats	X1				-	aridic	thermic	gentle	barren land	dryness salinity
Rock land	X2				-	-	-	steep	barren land	lack of soil

Definitions for table 2B-1

1/ Soil Fertility:

Fertility is expressed as high, medium, or low depending on such soil properties as base status, mineralogy, and wetness availability. These terms are comparative and have no quantitative values. On all soils, fertilizer must be used for continued high production of cultivated crops.

2/ Soil Moisture Regime:

Aquic--Wet soils, seasonally saturated with water.

Aridic--Soils normally in arid climates. These soils are dry throughout more than half the time that the soil temperature is above 41° F. They are never moist in any part for as long as 90 consecutive days when the soil temperature is above 47° F.

Udic--Soils normally in humid climates. Soils are moist but are not saturated during most of the growing season.

Ustic--Soils intermediate between Udic and Aridic. Moisture is limited but is available when conditions are suitable for plant growth. Soil management to conserve and utilize limited moisture necessary for highest production.

Xeric--Soils normally in a Mediterranean type of climate with moist cool winters and warm dry summers. Soils are moist in the winter, spring, and early summer; dry in late summer and fall.

3/ Soil Temperature Regimes:

Cryic--Mean annual temperature higher than 32° F but lower than 47° F.

Frigid--Mean annual temperature higher than 32° F but lower than 47° F. The difference between mean winter and mean summer soil temperature is more than 9° F. In a frigid soil temperature regime, summer temperatures are higher than those in a cryic soil temperature regime.

Mesic--Mean annual soil temperature higher than 47° F but lower than 59° F.

Thermic--Mean annual soil temperature higher than 59° F but lower than 72° F.

Hyperthermic--Mean annual soil temperature higher than 72° F.

Iso--Regimes (isofrigid, isothermic, etc.) have mean summer and mean winter soil temperatures that differ by less than 9° F.

4/ Slopes

Gentle--slopes mainly less than 10 percent.
Moderate--slopes mainly between 10 and 25 percent.
Steep--slopes mainly more than 25 percent.

are based on detailed soil surveys made at scales of about 1:20,000 or 1:15,840. This classification system does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely reclamation projects. It does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show the suitability and limitations of groups of soils for rangeland, forest trees, or engineering purposes.

National Summary

The United States has a high proportion of land in classes I-IV. Fifty-six percent (802 million acres) of nonfederal rural land is in these classes. Soils that are suitable for continuous cultivation of most field crops and for a wide range of other uses, such as woodland, urban land, or pastureland (classes I, II, and III) make up 43 percent of the nonfederal rural land, or a total of 614 million acres (figure 2B-2).

Soils that are marginal for cultivated crops because of unfavorable soil properties (class IV) make up about 13 percent of the nonfederal land, or 189 million acres.

Soils that are generally not suitable for cultivated crops but can be used for pasture, range, woodland, wildlife habitat, or recreation (classes V, VI, VII, and VIII) make up about 44 percent of the nonfederal rural land, or 633 million acres.

Summary by Farm Production Region

The Corn Belt, the Lake States, the Northern Plains, and the Delta States have the largest acreages of high quality soils for agricultural purposes (figure 2B-3).

In the Corn Belt, 76 percent of the acreage is suitable for continuous cultivation (classes I-III). In the Northern Plains, Lake States, and Delta States, more than 50 percent of the acreage is suitable for continuous cultivation. In contrast, the acreage suitable for continuous cultivation in the Mountain States is only 18 percent and in the Pacific States 25 percent.

The distribution of soils that are of marginal use for cropland (class IV) is fairly uniform, averaging 13 percent nationwide. In the Southeast and the Lake States, however, these soils represent 23 percent of the total land area.

Soils suitable for grassland occur throughout the Nation. Most soils in the East and a significant acreage in the Pacific and Mountain States are suitable for woodland.

Dominant Soil Conditions

The following general statements on soil productivity, compaction, slope, erosion, and wet soils and flood prone areas are based on data from the 1977

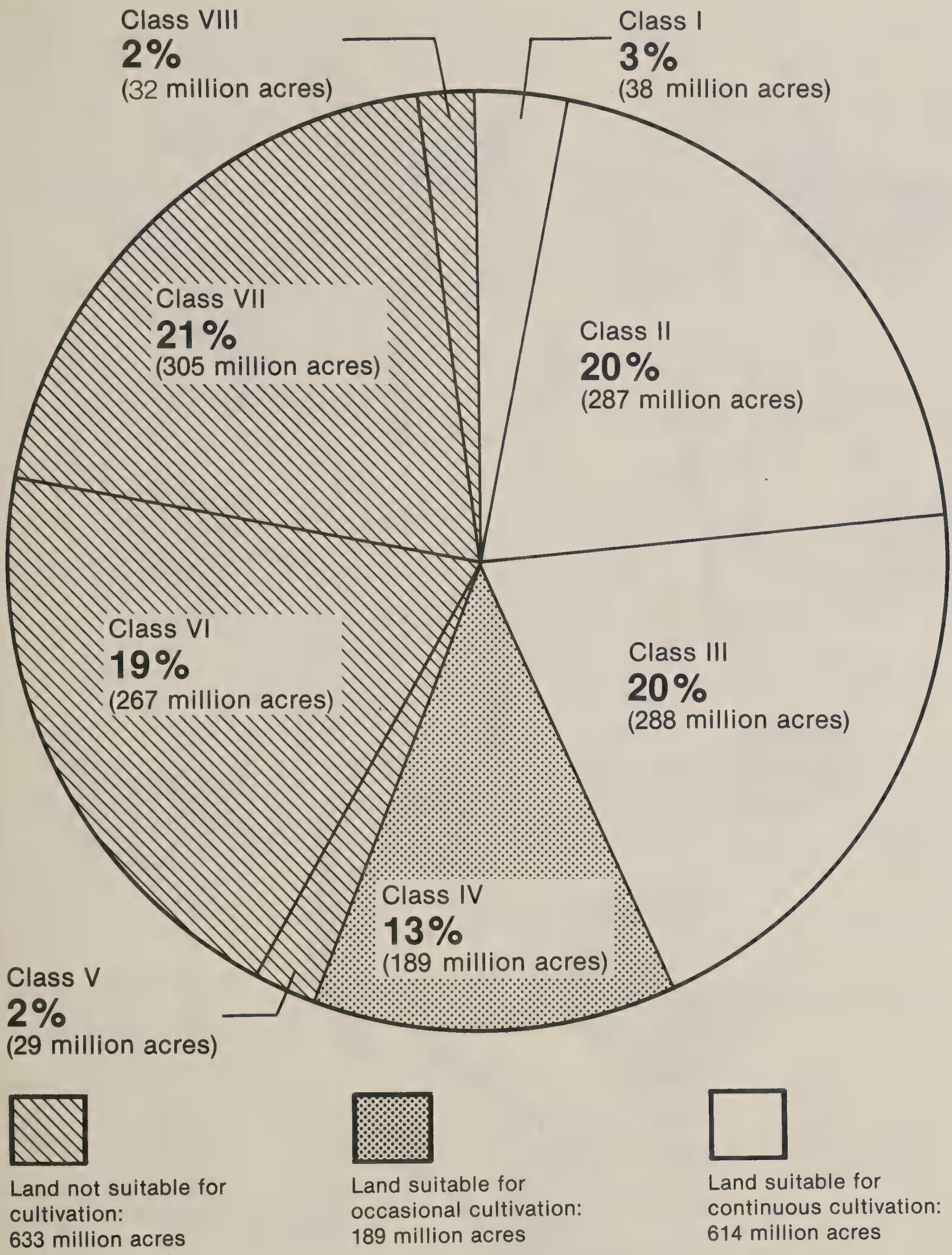


Figure 2B-2.--Land capability percentages for nonfederal rural land, 1977.

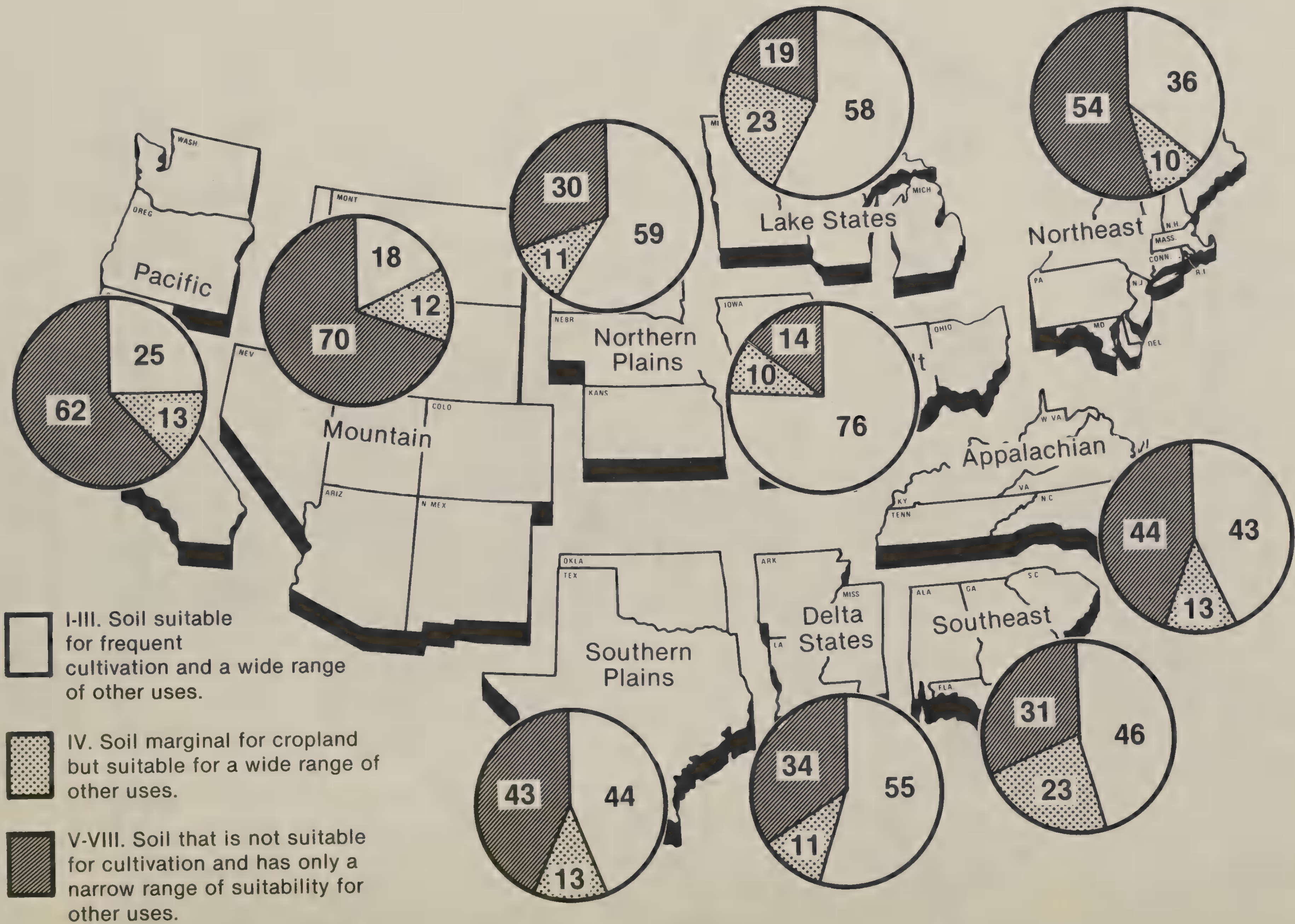


Figure 2B-3.--Percentages of soil in capability classes I-VIII, by farm production region.

National Resource Inventories (USDA, 1978) and information in the General Soil Map of the United States (USDA, 1975).

Soil Productivity.--Plants obtain most of their nutrients and moisture from the soil. An ideal soil is accessible to plant roots and can receive and store moisture in the root zone without becoming so saturated that it retards root development. It can also supply nutrients to plants and retain nutrients in the root zone during periods of excess moisture. Many soils do not have these ideal properties. In some soils it is difficult for soil moisture to penetrate. In others, moisture penetrates easily but little is retained in the root zone. Some soils are so compact that roots penetrate mainly along fracture planes, and moisture and nutrients are not easily accessible. Some have limited capacity to retain plant nutrients. Others can retain many nutrients. These and many other soil properties must be known in order to develop management practices that overcome unfavorable properties or take full advantage of the most favorable properties. The soil factors affecting productivity are fertility, moisture relationships, and temperature.

o Fertility.--Soils have varying amounts of the minerals that supply plant nutrients. Soils in glaciated areas generally have a great variety of mineral constituents because of mixing during glaciation. Soil developed in material weathered from sedimentary rock and material that was highly weathered before deposition contains fewer of the more soluble mineral constituents. Soils of this type occur on the coastal plains of the Southeast and South. Soil developed in material weathered from recently exposed rock contains varying amounts of nutrient-supplying minerals, depending on the nature of the rock formation.

In areas where there are periods of moisture surplus, the more soluble soil constituents are washed below the root zone. Consequently, these areas become increasingly infertile as they grow older. Where soils are nearly always dry or there are few periods when moisture moves below the root zone, few nutrients are lost through leaching. Different minerals vary in their solubility, however, so that an analysis of the total mineral content provides an incomplete picture of the capacity of the soil to supply nutrients.

Table 2B-1 shows the general fertility levels of the soils in the United States. The soils are rated high, medium, or low according to estimates of base status, mineralogy, and nutrient availability.

About half the soils of the United States have high natural fertility. This means that they may be fertile enough for growing crops successfully without applying fertilizer. Even where moisture and temperature are not limiting factors, however, highly fertile soils may require application of fertilizer for optimum production. Many of the highly fertile soils are in the Great Plains, the dry areas of the Mountain States, and the Corn Belt.

About one-third of the soils have medium or medium and low fertility. They require moderate amounts of fertilizer for crop production. These soils are in the Mountain States and in small areas east of the Rocky Mountains.

About one-sixth of the soils in the United States have low natural fertility. This means that it is difficult to produce crops without applying

fertilizer. Large amounts of complete fertilizer are needed for optimum production. These soils are in the Southeast, the Northeast, and the Lake States.

The use of commercial fertilizers has been steadily increasing (figure 2B-4). Domestic suppliers have been able to produce enough nitrogen and phosphate for our own needs and to increase exports of phosphate as well. Domestic sources of potash, however, have not kept pace with the demand and a major part of the potash used is imported.

o Soil Moisture.--Regardless of the nutrient supplies in the soil, no growth is possible without soil moisture. The distribution of the moisture in a soil must be considered in selecting the kinds of plants. Table 2B-1 shows the general soil moisture regime of soils in the United States. Most soils east of the Mississippi River have enough soil moisture in summer if they have appreciable capacity to store moisture (i.e., they are reasonably deep, permeable, not too steep, and not too sandy). The more frequent the rainfall, the less storage capacity is needed. Moisture supplies tend to decrease west of the Mississippi, except in the higher mountains and the areas adjacent to the Gulf of Mexico. The mountains in California, Oregon, and Washington have the highest precipitation in the conterminous states.

East of the Rocky Mountains, most precipitation falls in the summer, but west of the Rocky Mountains most of the precipitation falls in the winter. For example, the Central Valley of California has virtually no rainfall for about 6 months, from May through October. All of the deserts occur in the Western States. Few nutrients are lost through leaching in these states.

o Soil Temperature.--The commonly cultivated crops grow little until the soil temperature exceeds 41° F. Figure 2B-5 shows the mean soil temperatures for the conterminous states. Alaska and most areas adjacent to Canada have a mean soil temperature lower than 47 degrees. These areas (called frigid temperature regimes) have relatively short growing seasons, often less than 120 days. All have most of their precipitation in summer. In Alaska, except for coastal areas of the southern part, mean soil temperatures are usually less than 32° F and the subsoil is mostly frozen all year.

In the central part of the United States, the mean soil temperatures range from 47° to 59° F. These areas have mesic temperature regimes and growing seasons that may exceed 6 months. In the southern tier of states, the mean temperature ranges from 59° to 72° F. These areas have thermic temperature regimes. Southern Texas, southern Florida, much of Hawaii, and the Caribbean area have mean soil temperatures that exceed 72° F. These areas have hyperthermic temperature regimes and a continuous or nearly continuous growing season. Of these areas, all of Hawaii, except the higher elevations, and the Caribbean area have little seasonal variation in temperature. The two warmer areas provide more opportunities for multiple cropping and it is possible to grow crops that require long growing seasons such as cotton and sugar. Most coastal areas have less seasonal variation in climate than the rest of the country.

Figure 2B-5 does not show the temperatures at the higher elevations of the mountains and high plateaus in the Western States. Most of these have soil temperatures less than 47° F, and the valleys are warmer and usually drier.

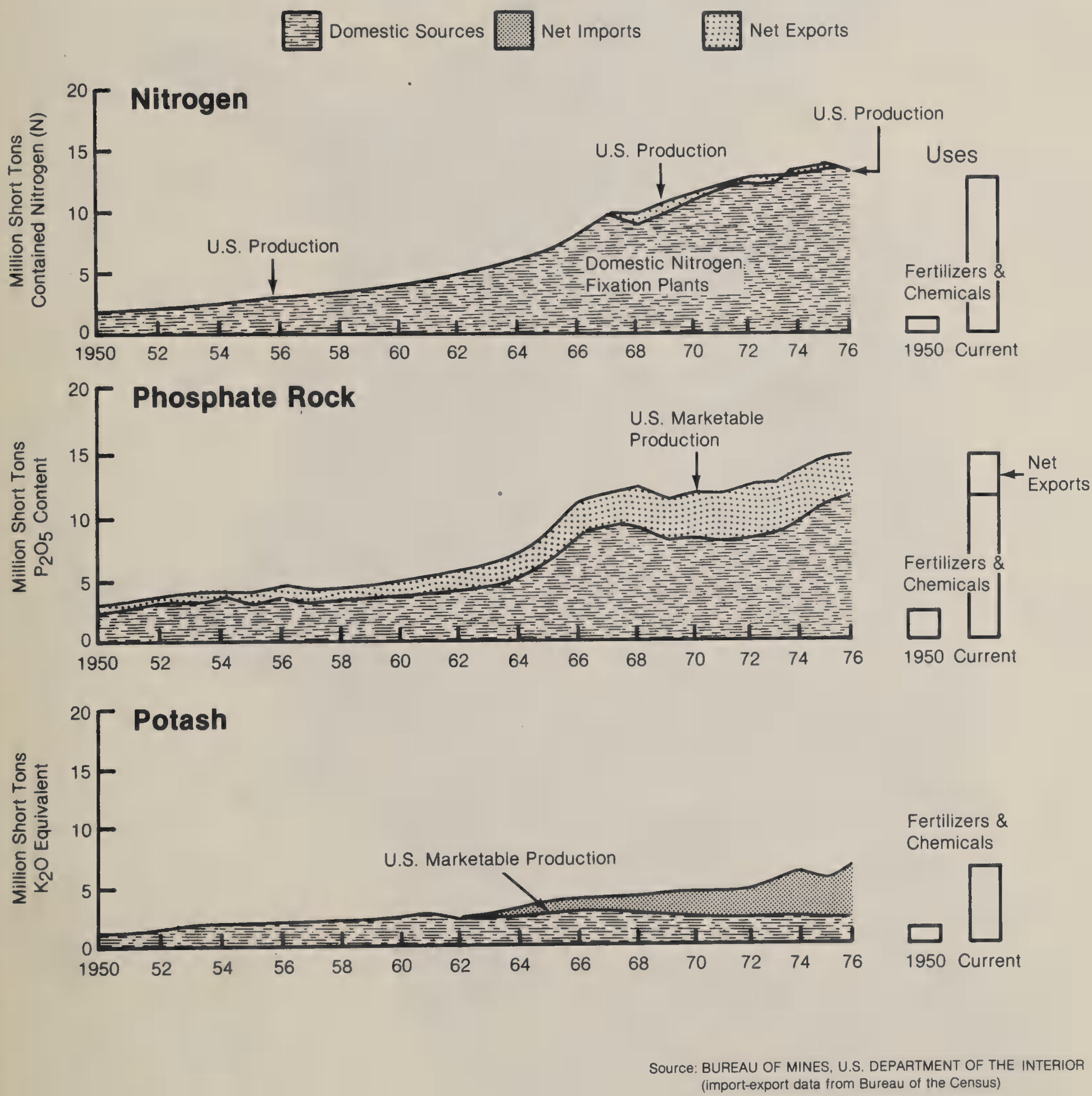


Figure 2B-4.--Sources and uses of major fertilizers in the United States.

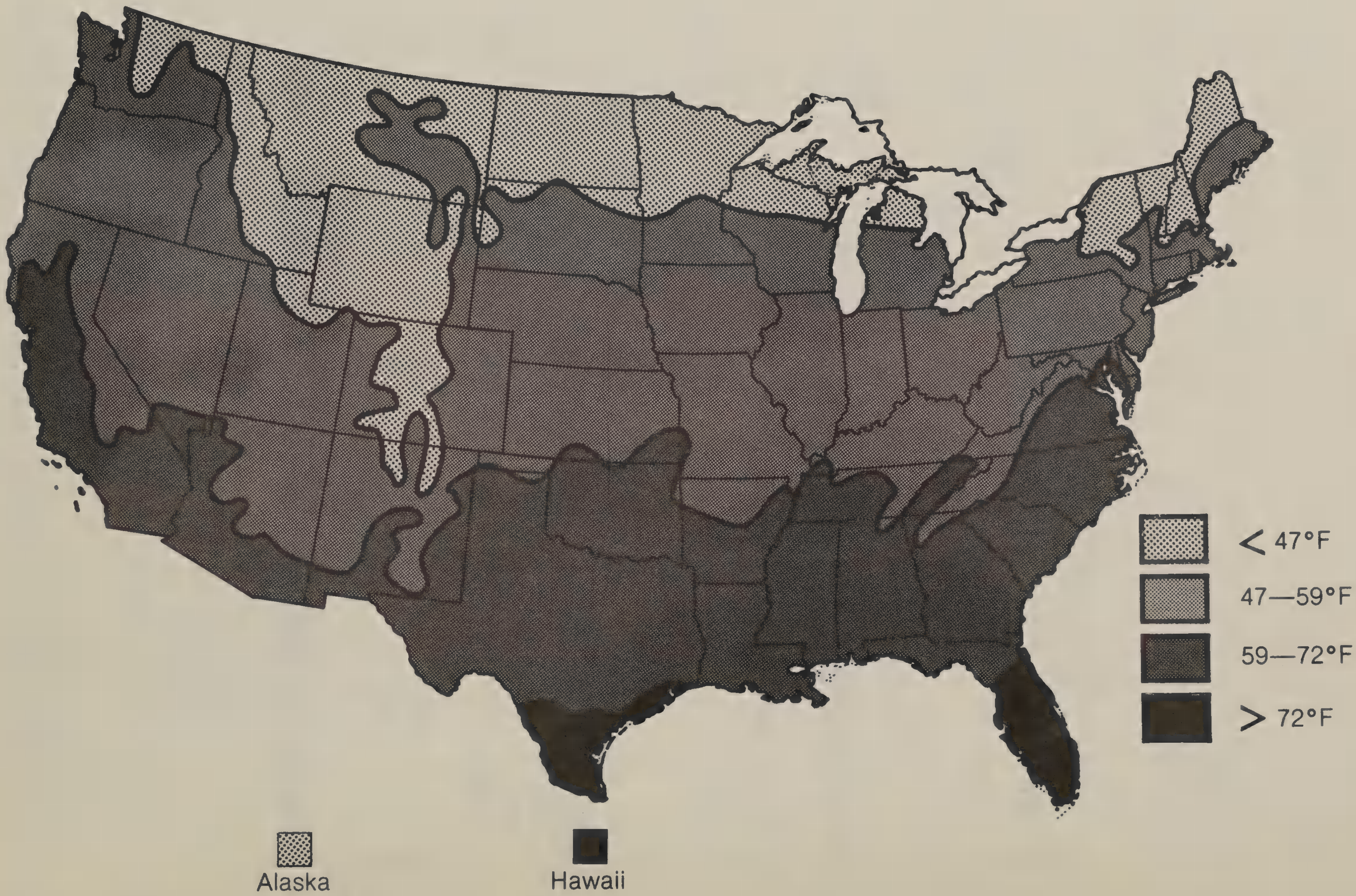


Figure 2B-5.--Mean soil temperatures.

In all these areas crops must be selected according to their temperature requirements. For example, small grains such as spring wheat, oats, barley, and flax are commonly grown in areas where the mean soil temperature is below 47° F, whereas corn, soybeans, and winter wheat are grown more successfully in warmer areas.

Soil Compaction.--Soil compaction is a serious problem in many cultivated areas. In general, the structure of the soil deteriorates under cropping, and the soil becomes compact and dense. There is adequate evidence that compaction and poor soil structure lower crop yields, decrease the rate of water infiltration, and increase runoff and erosion. In spite of the research, however, the direct cause and effect relationship is not well understood.

Compaction varies with the kind of soil, the amount of organic matter, and the surface texture. It also varies according to the kind and weight of the tillage equipment and the moisture content of the soil when it is tilled. Cropping systems and soil management systems can rebuild the structure and increase the supply of organic matter, thereby alleviating the effects of compaction.

Compaction decreases the porosity of soil and the infiltration of water into it and, therefore, contributes to runoff and erosion. It also decreases the movement of water and air in the soil and reduces the ability of the soil to hold water in a form that is available to plants.

Slope.--About 42 percent of the nonfederal agricultural land is level to gently sloping; 53 percent of this level to gently sloping land is cropland. About 31 percent of all the nonfederal agricultural land is steep and very steep; 3 percent of this acreage is cropland. The remaining 27 percent is sloping and moderately steep; 31 percent of it is cropland. These estimates were derived from the land capability data in the 1977 National Resource Inventories (USDA, 1978). Of the total nonfederal agricultural land in the United States and Caribbean area, about 28 percent (369 million acres) is level or nearly level, 14 percent (180 million acres) gently sloping, 16 percent (216 million acres) sloping, 11 percent (147 million acres) moderately steep, and 31 percent (413 million acres) steep and very steep.

Slope of the land influences how soils are used and managed. Table 2B-2 shows the slope of agricultural land by land use. About 45 percent of all cropland is level and nearly level. On these lands energy requirements for soil and crop management are the lowest and runoff is the slowest. Hence, the erosion hazard is lower than on any other lands. These areas are easiest to irrigate. One of the problems with level and nearly level soils is that runoff may stay on the land too long and either lower production, as a result of excessive wetness, or delay fieldwork unless the soil is artificially drained. In some areas, lack of air drainage and possible frost damage to sensitive crops may be problems.

Table 2B-2.--Slope of agricultural land by land use (percentage)

Slope	Cropland	Pastureland and native pasture	Range-land	Forest land	Total agricul-tural land
Level and nearly level (0 to 2 percent slopes)---	45	28	11	27	28
Gently sloping (2 to 6 percent slopes)---	25	18	4	10	14
Sloping (6 to 12 percent slopes)--	20	22	14	13	16
Moderately steep (12 to 20 percent slopes)-	7	14	14	11	11
Steep (20 to 45 percent slopes)-	2	10	26	12	13
Very steep (>45 percent slopes)-----	1	8	31	27	18

About 45 percent of the cropland is gently sloping and sloping. On these soils greater care is needed to slow runoff so that erosion does not lower productivity or cause gullies that may interfere with tillage. About 10 percent of the cropland is moderately steep to very steep. These soils have a high erosion hazard if they are left bare in high rainfall areas.

About 28 percent of the pastureland and native pasture is level and nearly level. These soils may be wet, but the erosion hazard is low and there are no problems in weed control or fertilization. On steeper slopes, use of machinery for weed control and fertilization becomes increasingly difficult. Controlling weeds and fertilizing on the 8 percent of the pastures that are very steep cannot be done with ordinary farm equipment.

Only 29 percent of the rangeland is less than moderately steep. Fourteen percent is moderately steep, 26 percent is steep, and 31 percent is very steep. The steeper slopes are more sensitive to erosion, and greater care is needed to keep the range in good condition and to protect it against deterioration. Animal trail erosion is a problem on the steeper slopes.

About 27 percent of the forest land occurs on level and nearly level slopes, and 27 percent on steep slopes. The rest is evenly distributed in the middle slope groups. Harvesting and planting are difficult on the steep slopes. Special equipment is needed for harvesting.

Soil Erosion.--The impact of soil erosion differs on different kinds of soils. The productivity of soils having subsoils with properties similar to those of the surface layer is affected least by erosion. If the subsoil has properties much less favorable for plant growth than the surface layer, the impacts of erosion on crop yields are much more severe. Soils can be seriously affected or totally destroyed by erosion because the entire root zone may be lost from soils that are shallow to bedrock.

The total extent of damage by erosion to the soil resource base is not known. Cropland is shifted to forest land or pastureland when erosion reduces yields from cropland to unprofitable levels. From 1967 to 1975, 53 million acres moved from cropland to pastureland and rangeland and 8 million acres from cropland to forest land (figure 2A-3). At least part of this acreage shift was caused by the marginal nature of eroded soil. Forest land and pastureland were brought into cultivation to partially offset the loss of cropland damaged by erosion (32 million acres from pastureland and rangeland and 11 million from forest land). As a result the total crop production has not been seriously diminished even though the potential production has been lowered.

Average annual soil loss was calculated for each of the sample sites in the 1977 National Resource Inventories. The Universal Soil Loss Equation was used to calculate sheet and rill erosion and another equation was used to calculate wind erosion. These equations are discussed in detail in Part II of the 1980 Appraisal.

o Sheet and Rill Erosion.--The acreage of soils having various rates of sheet and rill erosion are given for each state by land use in tables 2B-3 and 2B-4.

About 23 percent of the cropland (97 million acres) and 12 percent (47 million acres) of rangeland have erosion rates that exceed 5 tons per acre per year. On about 15 percent of the acreage of grazed forest, the erosion rate exceeds 5 tons per acre per year. On nongrazed forest the erosion exceeds this rate on only about 2 percent of the acreage.

Iowa has the largest acreage of cropland soil with high erosion rates. North Dakota has the largest acreage of cropland soil with very low erosion rates.

Tables 2B-5 and 2B-6 give the acreage of soils having various rates of sheet and rill erosion for each land capability class and subclass by land use.

The "e" subclasses have the greatest proportion of soils with high erosion rates.

Tables 2B-7 and 2B-8 give the acreage of wet soils having various rates of sheet and rill erosion for each state by land use. On about 17 percent of the cropland acreage, erosion exceeds 5 tons per acre per year. Practically no acreage of pasture, range, or forest has an erosion rate that exceeds 5 tons per acre per year.

o Wind Erosion.--In the Great Plains States, wind erosion exceeds 5 tons per acre per year on 38 percent of the cropland and 43 percent of the rangeland (table 2B-9). Table 2B-10 shows the distribution of soils with wind erosion by capability class and subclass.

Wet Soils.--Wet soils and wetlands are not the same. The "w" subclass in the SCS Land Capability Classification System indicates a potential hazard of wetness if the soil is used as cropland. SCS defines these soils as wet soils. Only a small percentage of the wet soils are wet enough to be in wetland types 3-20 as defined in Circular 39 (Shaw and Fredine, 1956). Table 2B-11 shows the acreage and percentage of wet soils, as indicated by capa-

Table 2B-3.--Sheet and rill erosion on cropland, pastureland, and native pasture, by state, 1977

State	Cropland				Pastureland and native pasture			
	Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)							
Alabama------------	861	1,151	1,274	1,212	3,681	320	99	22
Arizona------------	1,271	38	3	----	11	----	----	----
Arkansas-----------	792	3,169	3,083	945	3,756	848	451	571
California---------	9,494	356	138	84	1,028	76	19	4
Colorado-----------	6,872	3,180	640	400	1,323	126	88	62
Connecticut--------	125	28	14	34	103	6	3	----
Delaware-----------	209	254	51	27	20	1	1	----
Florida------------	1,883	574	480	251	5,339	89	55	----
Georgia------------	1,483	2,176	1,668	1,160	2,964	216	28	25
Hawaii-------------	117	67	33	76	602	198	89	103
Idaho--------------	4,699	789	433	366	1,060	----	3	49
Illinois-----------	6,193	8,808	5,124	3,685	2,010	417	271	368
Indiana------------	4,671	4,827	2,375	1,446	1,479	257	162	248
Iowa---------------	5,758	8,669	5,251	6,752	3,095	684	505	246
Kansas-------------	12,120	11,379	3,568	1,737	2,074	413	115	99
Kentucky-----------	2,172	1,286	959	1,009	3,619	843	487	787
Louisiana----------	946	2,028	2,218	706	2,743	115	49	38
Maine--------------	669	72	68	98	246	----	3	----
Maryland-----------	568	570	307	232	374	63	18	21
Massachusetts------	197	51	21	13	85	3	----	3
Michigan-----------	6,697	1,784	566	436	1,117	67	18	28
Minnesota----------	16,094	4,498	1,427	897	2,754	75	36	23
Mississippi--------	912	2,300	2,052	2,037	3,000	579	230	231
Missouri-----------	3,181	3,965	3,418	4,007	8,333	1,887	1,369	1,233
Montana------------	13,360	1,430	482	82	2,526	81	4	36
Nebraska-----------	9,628	6,371	1,891	2,808	2,114	424	142	218
Nevada-------------	1,107	----	----	----	264	37	----	----
New Hampshire------	233	24	10	6	95	----	----	----
New Jersey---------	340	128	163	145	141	1	----	3
New Mexico---------	1,507	674	65	36	340	1	----	40
New York-----------	3,576	1,072	632	689	2,046	133	59	47
North Carolina-----	1,638	2,173	1,286	1,093	1,608	246	168	7

Table 2B-3.--Sheet and rill erosion on cropland, pastureland, and native pasture, by state, 1977--Continued

State	Cropland				Pastureland and native pasture			
	Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)							
North Dakota--------	18,978	5,828	1,588	516	1,516	29	----	----
Ohio----------------	5,893	4,021	1,172	676	1,742	385	245	243
Oklahoma------------	4,699	4,487	1,909	688	7,067	1,136	388	123
Oregon--------------	4,468	467	166	46	1,695	72	----	----
Pennsylvania--------	2,824	1,189	830	816	1,385	198	106	109
Rhode Island--------	22	1	4	3	16	2	----	----
South Carolina------	875	1,518	631	307	1,187	26	24	5
South Dakota--------	11,658	4,561	1,150	786	2,388	18	7	----
Tennessee-----------	1,286	894	1,101	1,647	3,930	951	342	251
Texas---------------	11,710	12,406	5,110	1,212	15,872	1,856	595	444
Utah----------------	1,723	70	15	2	581	45	----	----
Vermont-------------	462	76	37	21	458	34	19	24
Virginia------------	1,376	838	421	573	2,105	479	332	358
Washington----------	6,086	1,305	452	106	1,216	20	16	----
West Virginia-------	617	221	83	69	835	340	368	494
Wisconsin-----------	6,306	3,112	1,467	855	2,174	313	165	86
Wyoming-------------	2,352	432	73	113	701	25	10	----
Puerto Rico---------	74	55	62	172	292	105	119	346
Total----------	200,782	115,372	55,971	41,077	105,110	14,240	7,208	6,995

Table 2B-4.--Sheet and rill erosion on range, forest land grazed, and forest land not grazed, by state, 1977

State	Range				Forest land grazed				Forest land not grazed			
	Erosion, tons/acre/year				Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)											
Alabama----------	----	----	----	----	1,162	346	75	36	16,841	1,124	191	24
Arizona----------	23,674	3,610	2,146	5,662	540	305	267	270	383	----	38	----
Arkansas---------	91	60	41	56	1,212	457	178	477	10,671	740	233	98
California-------	10,328	2,644	1,924	2,656	2,140	594	440	594	4,939	854	250	43
Colorado---------	15,644	3,880	1,808	2,456	1,598	438	185	454	562	106	----	----
Connecticut------	----	----	----	----	18	----	----	----	1,396	----	2	----
Delaware---------	----	----	----	----	1	----	----	----	358	1	----	----
Florida----------	2,992	25	----	----	2,831	125	16	----	9,167	----	----	----
Georgia----------	----	----	----	----	5	----	----	7	20,947	504	75	16
Hawaii-----------	----	----	---	----	80	33	19	24	1,029	78	57	123
Idaho------------	6,372	116	86	13	1,799	39	5	----	2,377	10	----	----
Illinois---------	----	----	----	----	190	117	78	214	2,203	190	32	----
Indiana----------	----	----	----	----	229	74	25	82	2,691	344	81	8
Iowa-------------	----	----	----	----	406	140	94	129	631	51	15	22
Kansas-----------	11,687	2,485	1,348	755	230	20	38	38	396	61	5	----
Kentucky---------	----	----	----	----	410	452	197	366	6,396	2,571	233	28
Louisiana--------	326	----	----	----	3,023	95	65	32	9,282	81	17	----
Maine------------	----	----	----	----	25	----	----	----	16,468	21	3	----
Maryland---------	----	----	----	----	63	3	5	6	1,894	164	18	4
Massachusetts----	----	----	----	----	37	----	----	----	2,552	146	21	----
Michigan---------	----	----	----	----	295	23	----	16	14,962	29	----	----
Minnesota--------	110	----	----	----	1,155	49	50	114	12,255	155	28	----
Mississippi------	16	10	----	5	1,938	200	101	94	10,973	867	189	45
Missouri---------	35	----	----	----	1,692	912	458	757	5,301	1,153	416	146
Montana----------	32,088	3,608	1,583	1,555	2,305	318	236	228	2,890	364	----	----
Nebraska---------	15,373	4,130	1,632	864	193	8	8	22	134	79	----	----
Nevada-----------	5,900	1,298	104	50	121	26	17	6	19	40	----	----
New Hampshire----	----	----	----	----	28	----	4	----	3,914	17	6	6
New Jersey-------	----	----	----	----	11	2	----	----	1,935	17	----	----
New Mexico-------	33,895	5,200	1,587	1,417	2,175	133	91	90	937	----	----	----
New York---------	----	----	----	----	525	47	23	12	13,897	709	218	14

Table 2B-4.--Sheet and rill erosion on range, forest land grazed, and forest land not grazed by state, 1977--Continued

	Range				Forest land grazed				Forest land not grazed			
	Erosion, tons/acre/year				Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)											
North Carolina---	----	----	----	----	642	93	----	----	16,064	24	----	----
North Dakota-----	9,742	388	189	239	141	8	----	----	217	----	----	----
Ohio-------------	----	----	----	----	317	143	99	184	4,189	678	232	22
Oklahoma---------	10,920	2,123	866	653	2,519	654	87	69	1,359	243	----	----
Oregon-----------	8,871	992	218	29	2,143	135	30	----	7,601	157	----	----
Pennsylvania-----	----	----	----	----	191	77	58	56	12,277	1,244	301	144
Rhode Island-----	----	----	----	----	4	----	----	----	295	3	----	----
South Carolina---	----	----	----	----	471	9	5	----	10,163	88	32	----
South Dakota-----	19,488	1,489	678	542	134	85	52	7	45	7	----	----
Tennessee--------	----	----	----	----	1,028	395	131	42	7,998	1,856	167	19
Texas------------	73,957	10,467	4,469	6,505	4,648	147	66	25	4,280	68	----	10
Utah-------------	7,261	1,087	463	548	543	182	65	110	146	20	----	----
Vermont----------	----	----	----	----	84	12	6	12	3,695	82	30	6
Virginia---------	----	----	----	----	670	152	114	162	10,420	980	523	213
Washington-------	4,972	776	211	44	2,425	78	45	88	9,697	88	92	----
West Virginia----	----	----	----	----	235	195	147	215	5,208	1,758	1,581	464
Wisconsin--------	4	----	----	----	1,006	219	120	207	11,220	302	158	14
Wyoming----------	19,538	2,681	2,288	1,664	653	49	83	111	212	41	14	----
Puerto Rico------	1	11	5	48	8	2	8	6	79	46	132	149
Total-------	313,285	47,080	21,646	25,761	44,299	7,591	3,791	5,362	283,465	18,161	5,390	1,618

Table 2B-5.--Sheet and rill erosion on cropland, pastureland, and native pasture by land capability class and subclass, 1977

Land capability class and subclass	Cropland				Pastureland and native pasture			
	Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)							
I---------	13,418	13,922	3,383	796	2,799	137	----	----
IIc-------	15,158	4,203	363	73	943	----	----	----
IIe-------	34,446	26,115	17,478	10,767	17,138	1,142	434	99
IIs-------	9,153	6,900	1,990	445	2,323	135	----	12
IIw-------	29,909	20,533	8,488	1,698	9,215	202	54	26
IIIc------	4,517	1,498	107	50	212	----	----	----
IIIe------	35,911	17,877	10,913	15,172	21,269	3,103	1,461	805
IIIs------	8,537	2,277	758	260	3,523	227	145	68
IIIw------	16,873	10,144	5,566	1,251	8,002	270	61	36
IVc-------	634	174	8	8	141	----	----	----
IVe-------	12,919	6,261	3,833	6,344	11,935	2,993	1,360	1,114
IVs-------	4,985	1,197	558	263	2,858	388	169	107
IVw-------	4,736	1,122	554	230	5,155	57	47	----
Ve--------	2	----	----	----	----	----	----	----
Vs--------	57	----	----	----	22	----	----	----
Vw--------	1,476	485	233	57	4,171	134	22	10
VIc-------	45	46	60	14	120	----	----	----
VIe-------	3,584	1,504	1,202	2,751	7,144	2,900	1,547	1,695
VIs-------	1,696	535	221	166	2,254	413	327	332
VIw-------	971	116	20	----	875	----	----	----
VIIc------	67	12	----	----	128	----	----	----
VIIe------	521	274	143	578	1,634	1,133	826	1,592
VIIs------	842	177	83	154	2,595	994	736	1,085
VIIw------	184	----	10	----	515	12	----	----
VIIIe-----	----	----	----	----	8	----	15	9
VIIIs-----	74	----	----	----	71	----	4	5
VIIIw-----	67	----	----	----	60	----	----	----
Total--	200,782	115,372	55,971	41,077	105,110	14,240	7,208	6,995

Table 2B-6.--Sheet and rill erosion on rangeland and forest land by land capability class and subclass, 1977

Land capability class and subclass	Rangeland				Forest land			
	Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
				(1,000 acres)				
I---------	714	30	----	----	1,912	12	8	----
IIc-------	3,171	28	10	20	700	----	----	----
IIe-------	9,016	572	83	67	21,849	180	71	15
IIs-------	1,382	22	10	----	3,082	14	----	----
IIw-------	2,135	35	----	----	15,380	71	7	27
IIIc------	3,010	44	----	----	82	----	----	----
IIIe------	34,674	2,415	882	226	27,569	739	236	103
IIIs------	3,012	93	7	49	7,180	156	69	107
IIIw------	3,456	129	52	----	21,756	76	41	6
IVc-------	2,475	38	15	----	213	----	----	----
IVe-------	33,969	3,249	1,331	623	24,173	1,564	394	329
IVs-------	4,570	159	46	23	11,141	439	160	191
IVw-------	3,267	18	8	----	20,972	99	8	----
Vc--------	15	----	----	----	7	----	----	----
Vs--------	94	16	8	----	368	----	8	5
Vw--------	3,557	246	29	----	16,207	26	22	----
VIc-------	3,712	177	8	22	229	----	----	----
VIe-------	79,461	15,748	6,705	4,894	37,301	5,133	1,671	1,170
VIs-------	25,052	3,522	1,336	1,785	30,268	905	346	237
VIw-------	4,391	46	----	32	6,006	4	----	----
VII-------	----	10	----	----	267	----	----	----
VIIc------	4,843	131	21	46	1	----	----	----
VIIe------	29,996	8,772	5,755	7,716	34,367	8,305	3,421	2,643
VIIs------	51,237	11,244	5,102	9,765	38,944	7,793	2,643	1,984
VIIw------	1,757	33	----	----	4,801	----	6	----
VIII------	607	25	30	84	283	29	----	----
VIIIe-----	532	53	82	140	482	112	48	110
VIIIs-----	2,989	214	126	254	1,250	95	22	53
VIIIw-----	191	11	----	15	964	----	----	----
Total--	313,285	47,080	21,646	25,761	327,764	25,752	9,181	6,980

Table 2B-7.--Sheet and rill erosion on wet soils in cropland, pastureland, and native pasture, by state, 1977

State	Cropland				Pastureland and native pasture			
	Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)							
Alabama----------	303	383	171	7	903	7	17	----
Arkansas---------	384	2,857	2,454	332	857	39	----	----
California--------	2,355	20	----	----	248	12	----	----
Colorado---------	472	15	----	----	333	----	----	----
Connecticut-------	24	11	----	3	20	3	----	----
Delaware---------	91	92	13	----	6	1	----	----
Florida----------	1,211	152	90	----	4,030	56	55	----
Georgia----------	458	298	112	10	468	----	----	----
Hawaii-----------	1	7	----	----	1	----	----	----
Idaho------------	510	13	----	----	345	----	----	----
Illinois---------	3,807	4,140	919	120	462	----	----	----
Indiana----------	3,306	3,161	923	136	558	8	7	----
Iowa-------------	3,086	3,563	765	416	950	----	29	15
Kansas-----------	851	810	225	12	252	10	7	----
Kentucky---------	409	316	162	34	286	4	5	9
Louisiana--------	816	1,924	1,992	396	1,449	65	8	----
Maine------------	213	12	15	4	103	----	----	----
Maryland---------	170	210	59	15	63	3	----	----
Massachusetts-----	68	13	11	3	21	----	----	----
Michigan---------	3,556	501	74	22	490	7	----	----
Minnesota--------	9,130	822	45	15	1,486	----	----	----
Mississippi-------	499	1,861	1,707	847	941	59	----	----
Missouri---------	784	2,256	1,794	270	880	68	7	16
Montana----------	492	----	----	----	297	----	----	----
Nebraska---------	1,707	762	113	13	400	7	----	----
Nevada-----------	595	----	----	----	130	----	----	----
New Hampshire-----	56	3	----	----	25	----	----	----
New Jersey--------	88	59	53	21	38	----	----	----
New Mexico--------	18	4	----	----	35	----	----	----
New York---------	1,753	459	198	144	782	7	----	5
North Carolina----	947	1,047	265	24	326	----	----	----

Table 2B-7.--Sheet and rill erosion on wet soils in cropland, pastureland, and native pasture, by state, 1977--Continued

State	Cropland				Pastureland and native pasture			
	Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)							
North Dakota----------	1,711	62	8	----	221	----	----	----
Ohio------------------	4,317	2,181	190	52	492	----	----	----
Oklahoma--------------	548	470	177	8	1,457	76	15	----
Oregon----------------	1,439	11	----	----	639	13	----	----
Pennsylvania----------	669	216	89	62	526	12	----	6
Rhode Island----------	5	----	1	1	3	----	----	----
South Carolina--------	368	672	123	----	131	----	----	----
South Dakota----------	1,274	167	5	----	277	----	----	----
Tennessee-------------	258	445	666	110	562	21	----	----
Texas-----------------	1,826	1,582	1,199	74	4,309	164	31	5
Utah------------------	446	----	----	----	98	----	----	----
Vermont---------------	167	26	10	6	122	9	3	----
Virginia--------------	247	236	87	16	275	----	----	----
Washington------------	438	----	----	----	388	----	----	----
West Virginia---------	157	34	14	----	140	12	----	5
Wisconsin-------------	1,819	514	120	54	992	7	----	8
Wyoming---------------	348	----	----	----	157	----	----	----
Puerto Rico-----------	19	13	12	9	19	5	----	3
Total------------	54,216	32,400	14,871	3,236	27,993	675	184	72

Table 2B-8.--Sheet and rill erosion of wet soils in rangeland, forest land grazed, and forest land not grazed, by state, 1977

State	Rangeland				Forest land grazed				Forest land not grazed			
	Erosion, tons/acre/year				Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)											
Alabama-----------	----	----	----	----	426	----	----	----	3,753	15	----	----
Arizona-----------	1,066	7	----	----	----	----	----	----	----	----	----	----
Arkansas----------	13	5	6	----	274	----	----	----	4,043	----	----	----
California--------	689	----	14	29	15	10	----	5	64	----	----	----
Colorado----------	563	30	----	8	14	3	----	----	4	----	----	----
Connecticut-------	----	----	----	----	----	----	----	----	116	----	----	----
Delaware----------	----	----	----	----	----	----	----	----	228	----	----	----
Florida-----------	2,767	15	----	----	2,337	87	8	----	5,787	----	----	----
Georgia-----------	----	----	----	----	----	----	----	----	8,706	3	----	----
Hawaii------------	----	----	----	----	2	----	----	----	29	----	6	----
Idaho-------------	192	----	----	----	17	----	----	----	25	----	----	----
Illinois----------	----	----	----	----	50	7	----	----	615	----	----	----
Indiana-----------	----	----	----	----	73	----	----	7	653	----	----	----
Iowa--------------	----	----	----	----	97	14	----	8	163	----	----	----
Kansas------------	1,058	35	7	10	100	----	----	----	211	4	----	----
Kentucky----------	----	----	----	----	19	4	----	----	316	----	----	----
Lousiana----------	306	----	----	----	1,452	16	7	----	5,262	----	----	----
Maine-------------	----	----	----	----	8	----	----	----	2,037	----	----	----
Maryland----------	----	----	----	----	25	----	----	----	693	----	----	----
Massachusetts-----	----	----	----	----	----	----	----	----	356	----	----	----
Michigan----------	----	----	----	----	177	----	----	----	5,707	----	----	----
Minnesota---------	42	----	----	----	428	----	----	----	6,187	----	----	----
Mississippi-------	----	10	----	----	501	7	----	----	4,180	----	----	----
Missouri----------	----	----	----	----	156	----	----	----	484	----	----	----
Montana-----------	1,135	----	----	----	51	2	----	----	63	----	----	----
Nebraska----------	995	15	8	----	108	----	----	----	40	----	----	----
Nevada------------	662	----	----	----	----	----	----	----	----	----	----	----
New Hampshire-----	----	----	----	----	6	----	----	----	285	----	----	----
New Jersey--------	----	----	----	----	----	----	----	----	574	2	----	----
New Mexico--------	286	3	----	----	----	----	----	----	----	----	----	----

Table 2B-8.--Sheet and rill erosion on wet soils in rangeland, forest land grazed, and forest land not grazed, 1977--Continued

State	Rangeland				Forest land grazed				Forest land not grazed			
	Erosion, tons/acre/year				Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)											
New York---------	----	----	----	----	166	----	----	----	3,002	6	19	6
North Carolina---	----	----	----	----	68	----	----	----	6,962	----	----	----
North Dakota-----	467	----	----	----	----	----	----	----	37	----	----	----
Ohio-------------	----	----	----	----	66	7	----	----	1,088	----	----	----
Oklahoma---------	843	31	8	----	318	----	----	----	75	----	----	----
Oregon-----------	154	----	----	----	42	----	----	----	78	----	----	----
Pennsylvania-----	----	----	----	----	63	7	7	----	1,117	3	7	----
Rhode Island-----	----	----	----	----	1	----	----	----	43	----	----	----
South Carolina---	----	----	----	----	95	----	----	----	4,864	----	5	----
South Dakota-----	1,121	----	----	----	----	----	----	----	----	----	----	----
Tennessee--------	----	----	----	----	56	----	----	----	839	----	----	----
Texas------------	5,654	363	46	----	2,306	63	17	7	1,614	----	----	----
Utah-------------	187	----	----	----	6	----	----	----	4	----	----	----
Vermont----------	----	----	----	----	1	----	----	----	280	----	----	----
Virginia---------	----	----	----	----	70	4	----	----	1,847	4	----	----
Washington-------	64	----	----	----	43	8	8	----	524	----	----	----
West Virginia----	----	----	----	----	9	----	----	----	123	----	----	----
Wisconsin--------	----	----	----	----	224	----	----	----	3,126	----	----	----
Wyoming----------	490	4	----	----	12	----	----	----	----	----	----	----
Total-------	18,754	518	89	47	9,882	239	47	27	76,204	37	37	6

Table 2B-9.--Wind erosion on cropland and rangeland in the Great Plains States, 1977

State	Cropland				Rangeland			
	Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
	(1,000 acres)							
Colorado	1,195	1,777	1,308	3,151	10	57	53	434
Kansas	7,381	3,941	2,861	2,182	168	113	86	306
Montana	3,722	3,757	1,869	1,546	40	----	----	----
Nebraska	2,923	1,625	733	645	952	237	30	110
New Mexico	245	344	439	787	9,837	4,823	3,318	6,628
North Dakota	11,135	5,603	2,301	303	127	47	20	102
Oklahoma	2,566	1,377	1,145	1,024	7	15	15	----
South Dakota	5,015	5,603	2,120	595	19	8	----	----
Texas	2,092	1,962	3,521	11,964	4,874	2,544	1,979	5,130
Wyoming	283	269	383	206	531	408	178	641
Total	36,557	26,258	16,680	22,403	16,565	8,252	5,679	13,351

Table 2B-10.--Wind erosion on cropland and rangeland in the Great Plains States, by land capability class and subclass

Land capability class and subclass	Cropland				Rangeland			
	Erosion, tons/acre/year				Erosion, tons/acre/year			
	<2	2-4.9	5-10	>10	<2	2-4.9	5-10	>10
				(1,000 acres)				
I---------	2,293	1,395	698	570	7	----	----	----
IIc-------	7,033	3,613	1,470	904	10	18	----	----
IIe-------	10,288	6,483	3,624	2,672	136	42	----	71
IIs-------	1,534	1,084	1,184	2,181	10	----	----	8
IIw-------	980	855	614	270	11	8	----	10
IIIc------	812	1,050	784	1,230	----	21	8	8
IIIe------	8,235	7,385	4,726	7,223	1,604	610	347	284
IIIs------	994	886	474	464	25	15	39	72
IIIw------	347	259	255	302	7	3	----	10
IVc-------	41	85	45	99	77	21	30	----
IVe-------	2,316	1,794	1,839	4,251	2,208	649	565	863
IVs-------	389	297	264	311	42	68	34	40
IVw-------	116	126	39	93	----	3	2	3
Vs--------	21	----	----	----	----	----	----	----
Vw--------	95	56	22	41	77	42	34	98
VIc-------	----	----	74	41	354	90	77	311
VIe-------	652	474	391	1,343	5,754	2,270	1,424	2,716
VIs-------	276	233	114	63	488	142	180	538
VIw-------	81	35	----	102	153	71	30	62
VIIc------	3	1	----	----	197	89	158	204
VIIe------	33	10	25	157	1,840	2,011	1,602	4,634
VIIs------	18	137	38	76	3,341	1,985	1,129	3,320
VIIw------	----	----	----	10	----	74	----	87
VIIIs-----	----	----	----	----	215	----	20	10
VIIIw-----	----	----	----	----	9	20	----	2
Total--	36,557	26,258	16,680	22,403	16,565	8,252	5,679	13,351

bility class and subclass, that are classified as wetland types 3-20. Data are from the 1977 National Resource Inventories (USDA, 1978).

Only 1 percent of the soils in IIw and 6 percent of those in IIIw are wet enough to be in wetland types 3-20. About 25 percent of the soils in IVw, Vw, and VIw are wet enough to be in wetland types 3-20. In contrast, most of the VIIw and VIIIw soils are in wetlands types 3-20.

Table 2B-11.--Acreage of wet soils classified as wetland types 3-20

Class and subclass	Wet soils 1/	Wetland types 3-20 2/	Percentage of wet soils that are wetland types 3-20
	Million acres	Million acres	
IIw	91	1	1
IIIw	72	5	6
IVw	41	11	26
Vw	29	6	21
VIw	14	4	27
VIIw & VIIIw	22	15	68

1/ 1977 National Resource Inventories (USDA, 1978). Table H, Rural land in 1977, by land use capability class.

2/ 1977 National Resource Inventories (USDA, 1978). Table N, Wetland types 3-20 in 1977, by land use capability class.

About 270 million acres of nonfederal land consist of wet soil. No data are available on how much of this land has been drained. It can be assumed, however, that most of the acreage now in cropland has either been drained or protected from flooding or that the wetness or flooding is not serious during the growing season.

Wet soils, which make up 25 percent of all cropland, or 105 million acres, are some of the most productive soils in the world. They are more fertile and contain more organic matter on the average than soils that are not so wet. The hazard of erosion is less serious, and less energy is needed to produce crops.

About 11 percent of all pasture, native pasture, and rangeland, or 57 million acres, is on wet soils. These are productive forage-producing soils. Many can be easily damaged in the wet seasons, however, by the trampling of livestock.

About 24 percent of all forest land, or 88 million acres, is on wet soils. These soils are highly productive of trees that are tolerant of wet soil conditions.

On about 91 million acres of the Nation's nonfederal rural land, short term wetness (IIw) is a problem. More than 60 million of these acres are cropland.

On about 113 million acres, wetness is a hazard during part of the growing season; 40 million of these acres are cropland (IIIw and IVw). Sixty-five million acres are ponded for a major part of the growing season (Vw, VIw, VIIw, and VIIIw) of which only 4 million acres are used for crops. Some of these crops are water tolerant, such as rice, wildrice, and cranberries.

The Southeast Region has the largest acreage of wet soils--46 million acres. The Corn Belt has 45 million acres, the Lake States have 44 million acres, and the Delta States 40 million acres. Minnesota, Florida, Texas, and Louisiana each have more than 17 million acres of wet soils. See figure 2B-6.

Flood Prone Areas.--Flood prone areas are lands adjoining rivers, streams, lakes or other areas where there is a 1 percent chance of flooding in any given year.

More than 175 million acres of nonfederal land are subject to flooding. About 28 percent of this acreage is cropland, 29 percent forest land, 20 percent rangeland, 11 percent native pasture and range, and 12 percent other land. About 54 million acres of the Nation's prime farmland, or 16 percent, are in flood prone areas. These soils are flooded mainly in the nongrowing season. They have a well aerated root zone during the growing season.

The Southeast, Delta States, Southern Plains, and Mountain States each have more than 20 million acres of flood prone areas. More flood prone areas occur in Texas, Minnesota, Louisiana, Mississippi, and Florida than in the other states. See figure 2B-7.

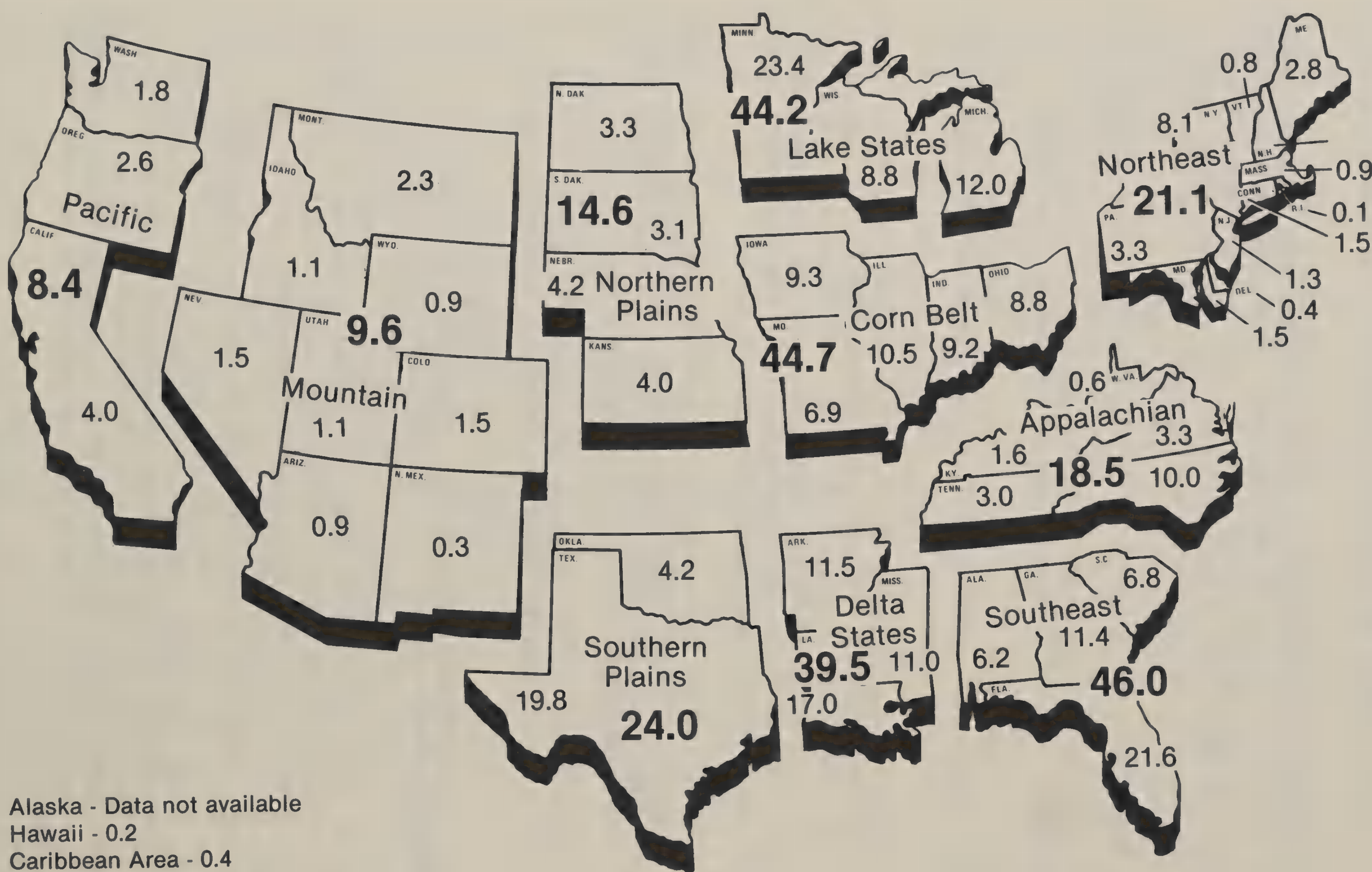
More than 50 percent of the flood prone acreage is used for cropland in Illinois, Indiana, Iowa, Kansas, Kentucky, Missouri, Nebraska, and North Dakota.

Trace Elements.--Trace element deficiency or toxicity sometimes occurs as crops and management change.

Trace element deficiency and toxicity often occur in animals because the plants that form their diet may contain too little or too much of certain trace elements. Examples of such problems are illustrated by five trace elements--cobalt, molybdenum, selenium, cadmium, and lead.

Cobalt deficiency, primarily a nutritional problem in ruminant animals, occurs when animals eat plants containing inadequate dietary levels of cobalt. Plants with inadequate cobalt levels appear to be as healthy as those with adequate levels because, except for certain legumes, this element is not essential for plant growth. Figure 2B-8 identifies general areas in the United States where cobalt deficiency lowers animal production (Kubota, 1968). Mineral supplementation is available to maintain animal productivity in these low cobalt areas.

Molybdenum is essential for plants. General locations where crops respond to molybdenum fertilization are known (Berger, 1962). The fact that molybdenum



Alaska - Data not available
Hawaii - 0.2
Caribbean Area - 0.4
Total - 271.1

Source: 1977 National Resource Inventories.
1967 Conservation Needs Inventory.

Figure 2B-6.--Wet soils by state and farm production region (millions of acres).

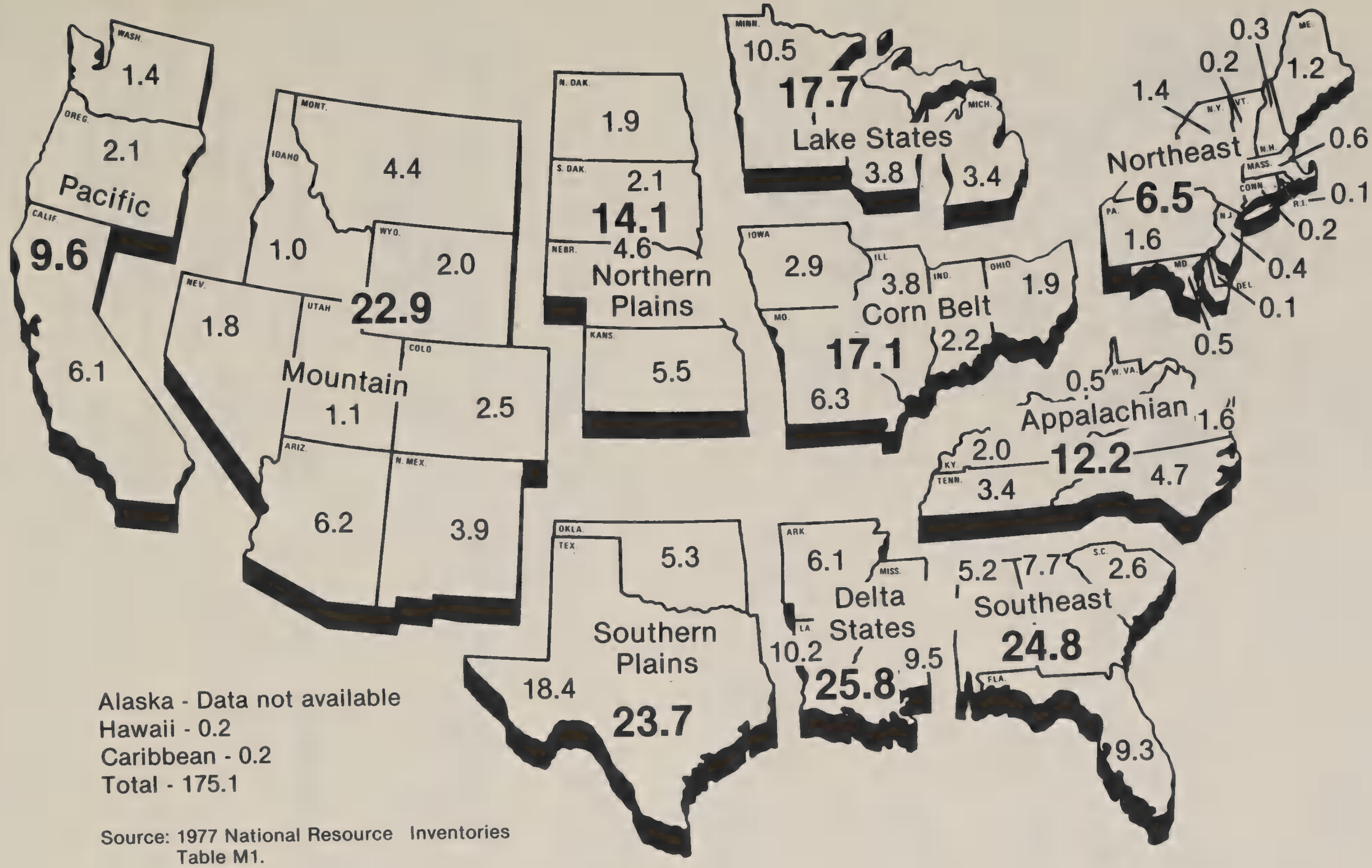
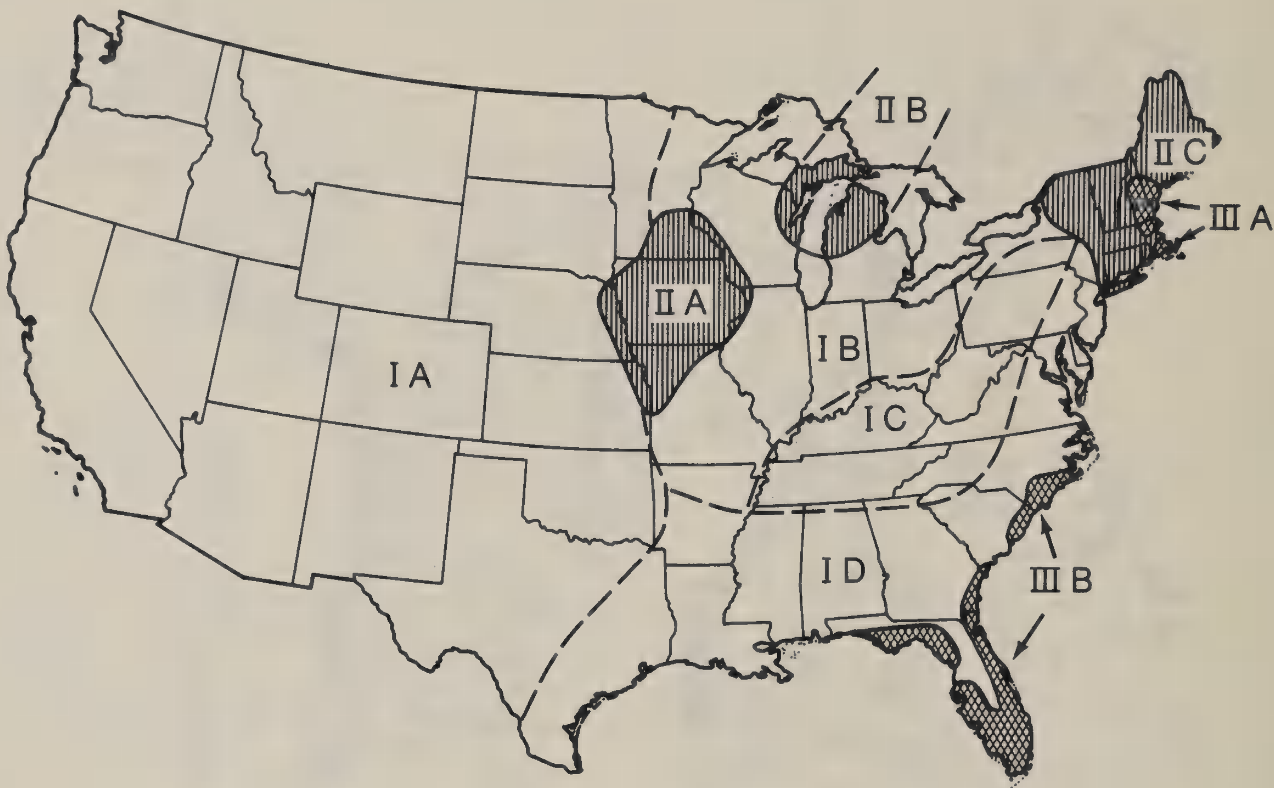


Figure 2B-7.--Flood prone areas in 1977, by state and farm production region (millions of acres).



LEGEND

	General Level of CO in Legumes (ppm)		Map Symbol	General Region
Areas of Adequate CO	0.1 to 0.2	☐	IA	Western United States and Great Plains States
			IB	North Central States
			IC	Ridge and Valley
			ID	Piedmont and Upper Coastal Plain
Areas of Moderately Low CO	0.1	▥	IIA	Central Loess and Drift Plains
			IIB	Northern Michigan
			IIC	New England and Northern New York
Areas of Low CO	<0.07	▩	IIIA	New England: Merrimac R.—Saco R. Drainage Basin
			IIIB	Lower Atlantic Coastal Plain

Figure 2B-8.--Cobalt levels in legumes in the United States.

is essential for ruminant animals has not been established, but it is known that exceedingly low or exceedingly high amounts in forage plants seriously affect animal growth. The general locations where molybdenum toxicity is a serious problem in animal production are shown in figure 2B-9 (Kubota, 1977). This figure also shows locations where molybdenum toxicity resulting from point source pollution has been observed in animals.

Selenium is essential for animals. Inadequate dietary selenium causes deficiency diseases in a wide range of animals. Exceedingly large amounts of selenium also cause toxicity in animals. The range of animal tolerance (from about 0.1 to less than 4 to 5 parts per million of selenium) is fairly narrow. Levels of selenium that impair animal growth have no detrimental effect on plants. Figure 2B-10 (Kubota et al., 1967) shows localized areas in the United States where selenium toxicity affects animals. It also shows broad areas where selenium deficiency diseases are likely to occur because of low plant selenium.

Cadmium and lead have little effect on plant production, but concentration of these elements may make plants unsuitable for human or domestic animal consumption. Large quantities of cadmium and lead in animal diets may cause failure of the organs in which they are concentrated. Localized work has been done on the chemistry of cadmium and lead in plants and soils but not to identify the source of crops and soils that furnish cadmium and lead to human diets. SCS now has a study underway to learn which crops and soils have excessive amounts of cadmium and lead. Similar studies are in progress to identify areas where other nutritional problems occur as a result of other causes:

1. Identification of naturally occurring areas of fluorosis in animals that graze on feed plants downstream from thermal springs, some of which are fluoride-rich sources (Kubota et al., manuscript cleared for publication).

2. Application of soil, plant, and climatic factors in identifying areas where stockmen must be aware of potential hazards from grass tetany, a conditioned magnesium deficiency in cattle (Kubota, Oberly, and Naphan, manuscript under revision).

3. Identification of zinc deficiency areas in the western states where low plant zinc concentrations may lower animal productivity.

4. Nutritional quality of range plants as reflected in their mineral composition.

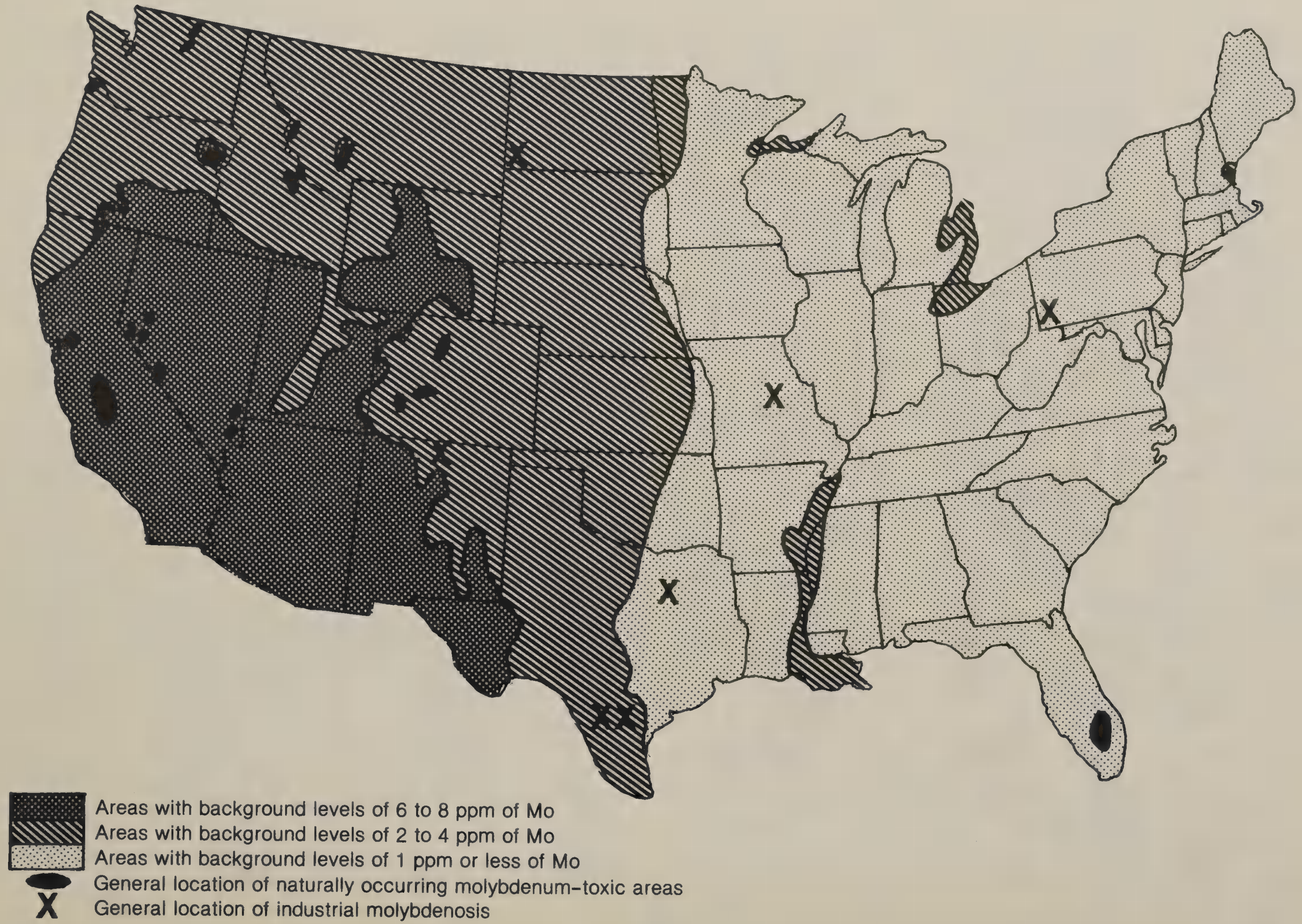


Figure 2B-9.--Molybdenum levels in the United States.

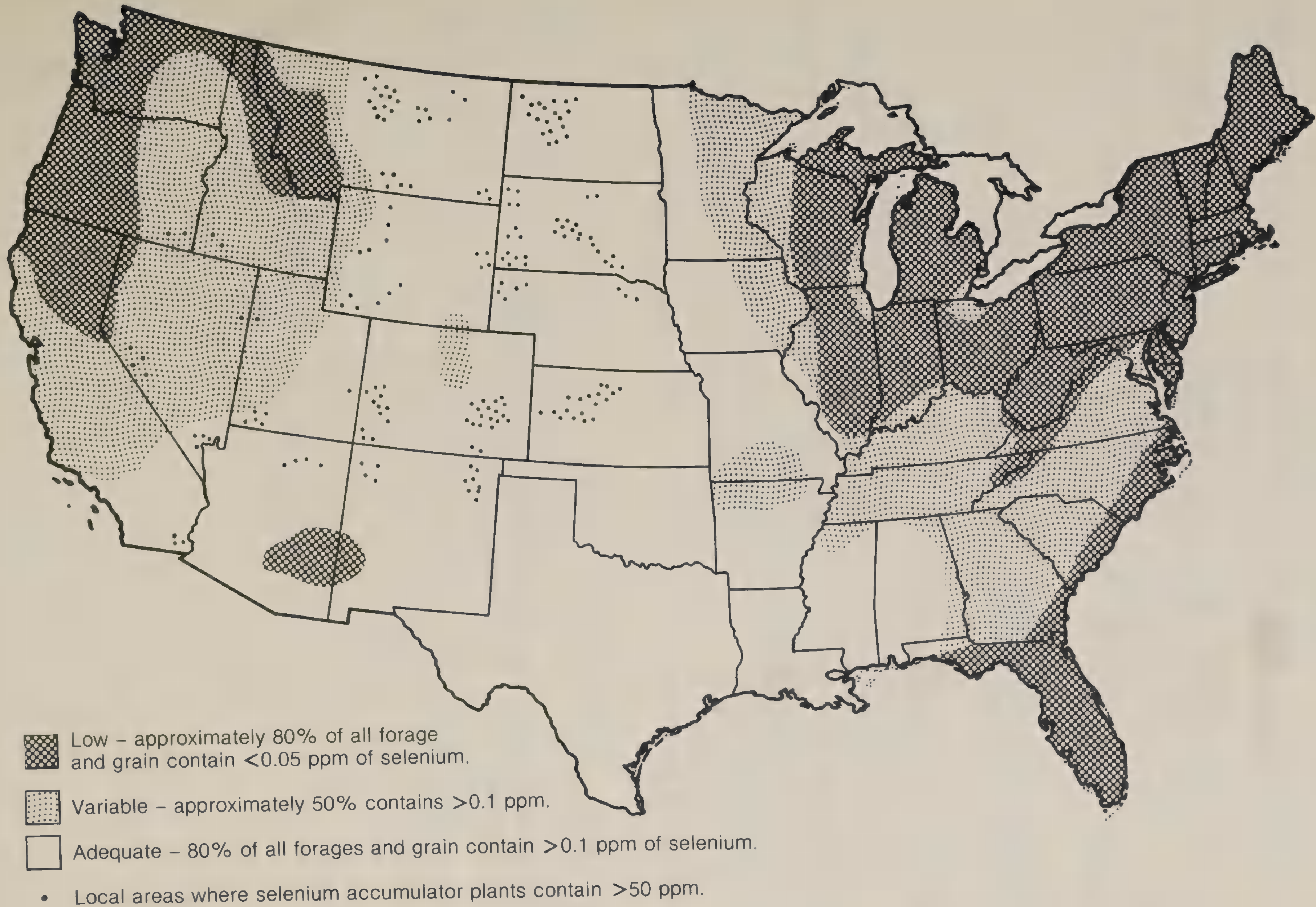


Figure 2B-10.--Selenium levels in the United States.

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Chapter 3 - Major Uses of Nonfederal Land

Section A-Cropland

Amount and Condition

In 1977 there were 413 million acres of cropland in the United States (excluding Alaska) and the Caribbean area under U.S. jurisdiction (USDA, 1978). Table 3A-1 breaks down this total acreage by capability class and subclass. The total figure includes land farmed to row crops, such as corn and cotton; to close-growing crops like wheat; and to orchards, vineyards, and legumes and grasses harvested for hay.

There was a 25 million acre reduction in cropland in the period 1967-77 (USDA, 1978). Much of this land was converted to pastureland, rangeland, and woodland. These land use changes reduce the risk of erosion. The cover of perennial vegetation inherent in these uses provides better protection from accelerated erosion than conventional farming practices.

These shifts in land use have improved the quality of cropland. As shown by a study in 1975, 86 percent of America's cropland was in capability classes I-III at that time, compared with 83 percent in 1967 and 1958. In 1975 only 10 percent of the cropland was in capability class IV, compared with 11 percent in 1967 and 1958. Cropland in capability classes V-VIII also declined--in 1975 it was 4 percent, compared with 5 percent in 1967 and 6 percent in 1958. Of the cropland in 1977, 58 million acres (14 percent) were irrigated (USDA, 1978). This is 30 percent more than in 1967 and 36 percent more than in 1958.

Soil Problems

Soils have characteristics that limit their use or necessitate special treatment. For agricultural interpretation, soils are assigned to capability classes and subclasses based on soil characteristics (Klingebiel and Montgomery, 1973). The classification system is explained in the glossary. Table 3A-1 shows the acres of cropland in the various capability classes and subclasses.

As shown in table 3A-1, class I land has no subclasses. These soils have few limitations or inherent weaknesses that complicate their use as cropland. By applying good farming techniques, one can successfully produce climatically adapted crops. The need for erosion control, water management practices, or special soil amendments is minimal. About 32 million acres of class I land are cropped (USDA, 1978).

Table 3A-1.--Acres of cropland in 1977, by capability class and subclass

Capability class	Capability subclass and dominant limitation						
	No major limitations	Erosion suscepti-bility (e)	Soil limitation, rooting zone (s)	Excess water (w)	Climatic limitation (c)	Other (1/)	Subtotal
	(1,000 acres)						
I--------	31,529	----	----	----	----	----	31,529
II--------	----	88,759	18,499	60,650	19,794	----	187,702
III-------	----	79,866	11,830	33,836	6,178	----	131,710
IV--------	----	29,348	6,986	6,650	822	----	43,806
V---------	----	----	----	2,306	----	----	2,306
VI--------	----	9,044	2,617	1,109	166	----	12,936
VII & VIII----	----	----	----	----	----	3,178	3,178
Subtotal-	31,529	207,017	39,932	104,551	26,960	3,178	----
Total---	----	----	----	----	----	----	413,167

1/ Subclass not differentiated.
Source: 1977 National Resource Inventories (USDA, 1978)

Sheet and Rill Erosion.--Sheet erosion, the removal of a fairly uniform layer of soil material, is caused by the action of rainfall and by surface runoff. Rill erosion, the formation of small channels, is the result of surface runoff.

o The erosion process.--Erosion occurs where water, wind, or other erosive agents remove soil or rock from slopes that have not been disturbed by man. This is geologic erosion.

In arid and semiarid regions these processes are rapid and erratic. Infrequent but torrential rains carve the hills and scour the valleys. The sparse vegetation offers little protection. The result is a landscape of angular forms. Flat-topped mesas and concave slopes are characteristic.

Before it was disturbed by man, the soil in humid and subhumid regions was held in place by dense forests and prairies. Here normal erosion is usually less rapid than soil formation. Hilltops are rounded and slopes are gently curved. Sharp angles and straight lines in the landscape are unusual.

The first settlers found the land in general equilibrium with the climate. But erosion speeded up as they cleared away the vegetation to grow crops, cut the timber, or let their livestock overgraze the grasslands. This "accelerated" or manmade erosion is the significant concern.

Water erodes the soil in three principal steps: (1) soil particles are loosened by the impact of raindrops or the scouring action of runoff, (2) detached particles are moved by flowing water, and (3) the particles are deposited at new locations. The combined actions of beating rain and flowing water remove continuous layers of soil from fields. This is called "sheet erosion." If the water moves fast enough, it dislodges soil and carries it along with soil particles splashed up by the raindrops. This scouring action carves out small channels and the water moves as a rill in what is called "rill erosion." The rills may join to form larger channels. Channels so deep that they cannot be smoothed by ordinary cultivation are "gullies."

o Rate of erosion.--The estimated average annual sheet and rill erosion in 1977 was 4.8 tons per acre for all cropland in the U.S. (excluding Alaska) and the Caribbean (USDA, 1978). The rate was 5.4 tons on cultivated land, excluding cropland in sod crops and other special cover. The highest average was 15.4 tons on sloping cropland in capability classes VII and VIII.

Cropland with erosion as the dominant limitation (subclass e, 207 million acres) averaged 6.7 tons of soil loss per acre (USDA, 1978). Forty-one percent of the cropland (IIe and IIIe) contributed 50 percent of all cropland erosion; 7 percent of cropland (IVe) contributed 13 percent of the erosion; and 3 percent of cropland (VIe, VII, and VIII) contributed 9 percent. Table 3A-2 and figure 3A-1 give sheet and rill erosion data by states.

o Special areas of sheet and rill erosion.--The following paragraphs describe five major land resource areas where erosion is a significant problem (Austin, 1972).

1. Aroostook County, Maine

Aroostook County, Maine's largest and northernmost county, is 6,453 square miles and larger than Connecticut and Rhode Island combined. Major population growth and development in the area began with potato production in the latter half of the 19th century. The major part of the county's potato production is in the Aroostook River Valley, which is a center for shipping, processing, and selling potatoes.

Aroostook County is located in two major land resource areas. The western and northwestern parts of the county are in the Northeastern Mountains. More than 90 percent of this area is in northern hardwoods, spruce, and fir. Less than 5 percent of the area is cropland or pasture. The eastern part of the county is in the Aroostook Area which covers 2,500 square miles. Nearly all the land is farmed, and between one-half and three-fourths is cleared and cropped. The major crop is potatoes.

Table 3A-2.--Estimated average annual sheet and rill erosion on cropland in tons per acre, by states, excluding Alaska (1977)

States	All cropland	Land capability and subclass IIe	IIIe	IVe
Alabama	8.9	8.8	11.3	18.3
Arizona	0.45	0.6	1.25	2.5
Arkansas	6.5	8.6	18.4	35.1
California	0.8	1.65	1.2	2.7
Colorado	2.5	1.5	2.2	2.6
Connecticut	4.1	5.3	9.1	4.1
Delaware	3.5	5.9	7.2	9.25
Florida	4.2	11.5	15.7	(1/)
Georgia	6.6	6.8	13.1	14.0
Hawaii	13.7	3.3	11.1	26.5
Idaho	2.4	0.8	3.1	6.2
Illinois	6.7	8.4	15.8	18.6
Indiana	5.15	7.5	10.9	20.6
Iowa	9.9	7.5	19.0	29.7
Kansas	3.8	3.2	5.3	6.45
Kentucky	9.4	6.1	9.3	17.1
Louisiana	7.9	9.3	10.9	(1/)
Maine	3.0	3.7	4.1	11.7
Maryland	6.1	6.1	8.9	12.3
Massachusetts	2.1	1.8	8.9	3.0
Michigan	2.3	2.9	5.1	8.4
Minnesota	2.3	3.45	6.1	12.0
Mississippi	10.9	9.7	22.8	27.0
Missouri	11.4	9.7	18.6	25.75
Montana	1.1	0.4	1.1	2.55
Nebraska	5.7	3.5	9.4	13.1
Nevada	0.04	0	0	0.06
New Hampshire	1.1	1.0	2.8	1.0
New Jersey	6.5	8.85	10.45	18.8
New Mexico	2.0	2.0	2.1	1.8
New York	4.85	5.2	7.9	9.5
North Carolina	7.6	11.8	16.25	17.7
North Dakota	2.0	1.9	3.0	2.9
Ohio	3.6	4.3	7.0	7.9
Oklahoma	3.7	4.2	3.6	4.8
Oregon	1.1	0.9	1.9	2.5

Table 3A-2.--Estimated average annual sheet and rill erosion on cropland in tons per acre, by states, excluding Alaska (1977)--Continued

States	All cropland	Land capability class and subclass		
		IIe	IIIe	IVe
Pennsylvania----------	5.5	5.5	6.2	7.65
Rhode Island----------	3.0	7.0	(1/)	(1/)
South Carolina--------	4.8	7.9	8.2	14.2
South Dakota----------	2.45	3.0	3.3	5.6
Tennessee-------------	14.1	12.7	15.6	27.9
Texas-----------------	3.5	4.0	3.5	3.4
Utah------------------	0.55	0.3	0.8	1.5
Vermont---------------	2.0	2.2	3.1	3.0
Virginia--------------	6.6	4.9	9.5	11.7
Washington------------	1.5	0.7	2.1	1.7
West Virginia---------	3.65	2.7	4.8	4.6
Wisconsin-------------	3.6	3.4	4.9	7.75
Wyoming---------------	1.6	0.6	2.1	3.2
Caribbean area--------	40.6 2/	0.55	5.3	14.35

1/ None of these soils are used for cropland.
2/ Forty-eight percent of the cropland in the Caribbean area is in land capability classes VI, VII, and VIII.
Source: 1977 National Resource Inventories (USDA, 1978)

Slopes in cultivated fields range from nearly level to 25 percent. The predominant soil is Caribou gravelly loam. Since cultivation began, much of the land has lost the upper 24 inches of soil. Because this soil horizon was so favorable for plant growth, soil erosion was often ignored until the hard, compact subsoil beneath became part of the plowed layer. This affected soil management and crop yields.

Because potatoes are so well adapted to the area, they have become the predominant crop and about the only cash crop. The economy of the area relies almost entirely on the production of potatoes. As a result, much of the land is devoted to continuous potato production. This highly intensive land use causes excessive rates of soil loss from water erosion. Some fields have lost as much as 1 inch of soil per year for the past several years. The average potato field is losing in excess of 15 tons of soil per acre, per year. Present productivity cannot be maintained with this rate of soil erosion.

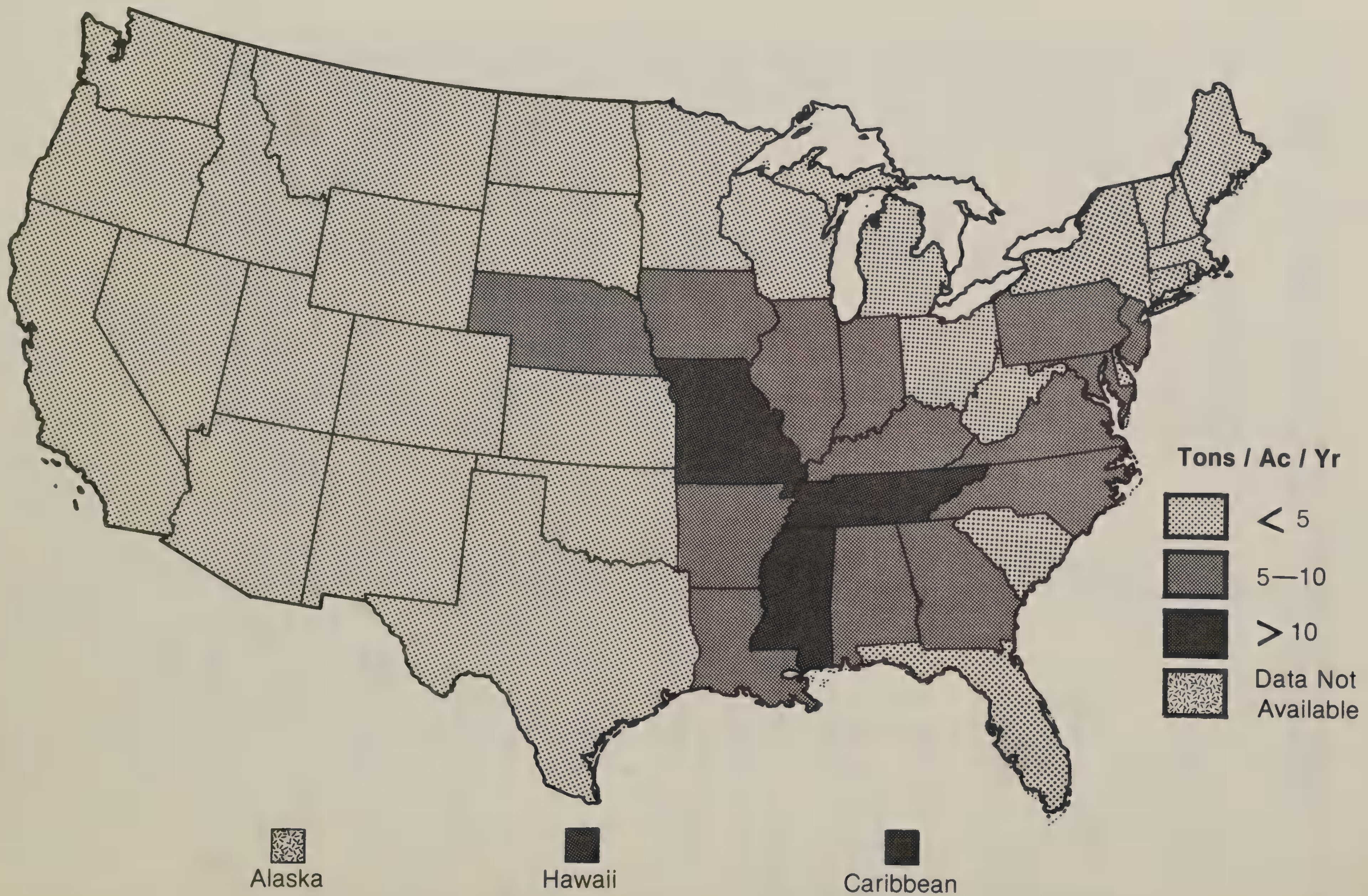

Figure 3A-1.--Sheet and rill erosion on cropland.

2. Palouse and Nez Perce Prairies and the Columbia Plateau

The Palouse and Nez Perce Prairies and Columbia Plateau major land resource areas cover 9,200 square miles in eastern Washington, north-central Oregon, and west-central Idaho. About 40 percent of the area is in cropland, nearly all of which is dryfarmed to wheat, barley, peas, and lentils. Some of the highest dryfarmed wheat yields found anywhere are in this area.

Water erosion is the dominant erosion problem on about 74 percent of the dryfarmed cropland. Precipitation averages from 10 to 23 inches. Most occurs in fall, winter, and spring. Summers are usually dry.

In the Palouse most cropland is hilly and steep. Slopes average 15 to 25 percent. On some cropland in this area, slopes are more than 50 percent.

Where vegetative cover is inadequate on these steep slopes, runoff from melting snow and occasional heavy summer rains causes much erosion damage, about 50 to 100 tons per acre.

3. Southern Mississippi Valley Silty Uplands

The Southern Mississippi Valley Silty Uplands major land resource area covers approximately 26,000 square miles in the western parts of Kentucky, Tennessee, and Mississippi, an area northwest of the Mississippi River in Louisiana, and Crowley's Ridge in eastern Arkansas. In the early 1970's about one-third of the area was cropland.

The sharply dissected plains have a thick loess mantle. Valley sides are hilly to steep, and the cropland generally is gently sloping to moderately steep. The loess soils are deep, fertile, productive, and erodible. Because of the productivity of these soils, large amounts of row crops are grown without any conservation practices. Therefore, the soils are exposed to erosion. On much of this land, the estimated soil loss averages as high as 20 tons per acre annually.

Because of the erosion in these areas, the five-state average annual erosion is 9.5 tons per acre of cropland. This is 4.7 tons per acre above the national average.

4. Loess, Till, and Sandy Prairie; Nebraska and Kansas Loess-Drift Hills; and Iowa and Missouri Deep Loess Hills

These major land resource areas are in eastern Nebraska, Kansas, and South Dakota and in southwestern Minnesota, western Iowa, and northwestern Missouri.

The topography is gently sloping to moderately steep. Many of the soils have been deposited by wind, and they are generally high in silt and very erodible. Some of the windblown deposits range from 40 to 100 feet deep in

the Iowa and Missouri Deep Loess Hills. Water erosion is a serious hazard because of the steep slopes and intensive cropping. The principal crops are corn, soybeans, and alfalfa hay.

5. Central High Plains and Central High Tableland

These major land resource areas are in eastern Colorado, southeastern Wyoming, southwestern Nebraska, and western Kansas.

The topography ranges from level to very steep. Because of the dry climate and steep slopes, both wind and water erosion are severe problems. Winter wheat and sorghum are the principal dryland crops. Corn is the principal crop under irrigation.

Wind Erosion.--Wind erosion is caused by a strong turbulent wind blowing across an unprotected soil surface that is smooth, bare, loose, dry, and finely granulated. Soil particles start to move when the wind force overcomes gravity. Where the soil is a mixture of single-grained material, the practical windspeed that starts movement under field conditions is about 13 miles per hour at a height of 1 foot. After soil particles start to move, they are carried by the wind in three types of movement--suspension, saltation, and surface creep. Soil blowing usually starts on exposed knolls, in tracks on paths made by implements or animals, and in turn rows where the vegetation and surface soil have been pulverized. Once blowing begins, the soil particles abrade the surface. The abrasion breaks down clods and wears down vegetative residues and living vegetation (Woodruff et al., 1972).

Figure 3A-2 shows the states that have a significant problem of wind erosion on cropland. Although wind erosion is prevalent in other areas, the brunt of the damage to cropland is in the Great Plains States. Table 3A-3 gives estimates of the average annual wind erosion for these states. As shown in tables 3A-3 and 3A-4 and figure 3A-2, wind erosion is most damaging in Colorado, New Mexico, and Texas. In these states, the average annual wind erosion on cropland is about 8.9, 11.5, and 14.9 tons per acre, respectively (USDA, 1978). As would be expected, the wind erosion problem in these states is most common on soils that are susceptible to erosion (table 3A-5).

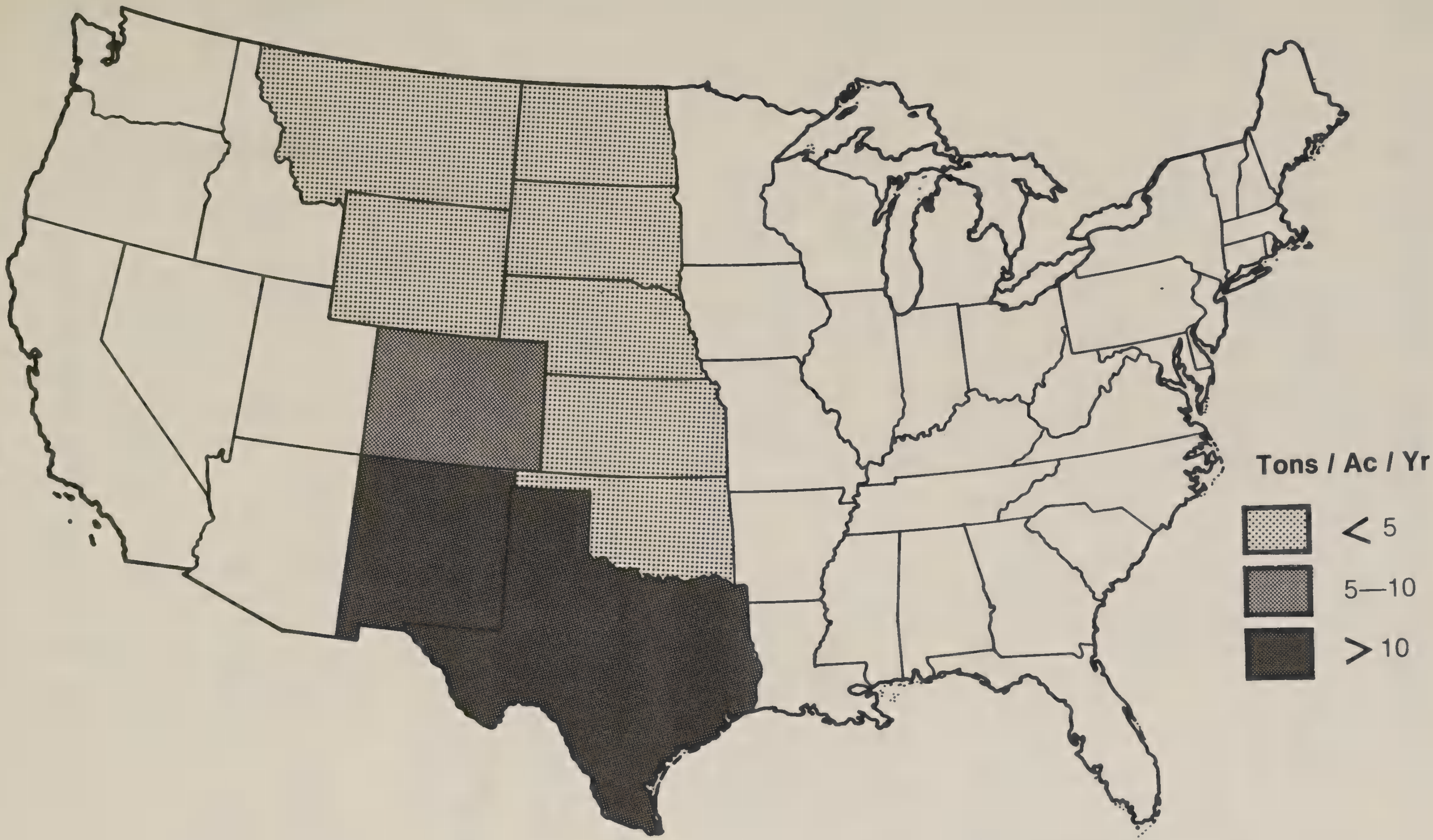

Figure 3A-2.--Wind erosion on cropland in the Great Plains States.

Table 3A-3.--Wind erosion on cropland in the Great Plains States, by major soil limitations

Great Plains states	Major limitation				
	No major limitations 1/	Erosion susceptibility (e)	Soil limitation, rooting zone (s)	Excess water (w)	Climatic limitation (c)
	Tons per acre				
Colorado------------	2.3	10.1	6.4	1.0	9.3
Kansas--------------	2.9	3.1	1.7	0.8	3.6
Montana-------------	2/	4.1	2.6	2.0	1.1
Nebraska------------	0.6	1.5	1.0	0.2	1.9
New Mexico----------	4.9	13.9	7.4	2.1	0
North Dakota--------	2/	2.0	1.4	2.3	1.0
Oklahoma------------	1.5	3.7	0.9	1.5	3.7
South Dakota--------	1.9	3.0	2.3	1.9	1.9
Texas---------------	5.1	20.0	11.8	3.8	10.1
Wyoming-------------	2.2	2.7	2.7	0.9	2.6

1/ Class I land.
2/ No Class I land.
Source: 1977 National Resource Inventories (USDA, 1978)

Table 3A-4.--Estimated average annual wind erosion from cropland, in tons per acre, in the Great Plains States (1977)

Great Plains states	All cropland	Land capability class and subclass				
		IIe	IIIe	IVe	VIe	IIs
	Tons per acre					
Colorado-----	8.9	3.9	5.2	11.9	15.2	3.1
Kansas-------	2.9	2.2	2.4	6.2	8.4	1.7
Montana------	3.8	1.25	3.8	7.2	5.6	2.75
Nebraska-----	1.25	1.05	0.8	2.1	5.9	0.65
New Mexico---	11.5	11.5	10.8	18.5	20.5	6.9
North Dakota-	1.8	2.0	1.8	2.6	2.1	2.5
Oklahoma-----	3.0	2.1	4.1	5.3	3.25	0.6
South Dakota-	3.0	4.1	3.9	4.4	3.6	1.8
Texas--------	14.9	7.0	15.6	57.45	101.55	11.9
Wyoming------	2.4	2.9	3.5	2.3	0.3	4.2

Source: 1977 National Resource Inventories (USDA, 1978)

Table 3A-5.--Proportion of wind erosion from cropland in subclass "e" (erodible) in Colorado, New Mexico, and Texas

States	Wind erosion on "e" subclass as a percentage of wind erosion on all cropland soils	Cropland in "e" subclass as a percentage of total cropland
Colorado------------------	70.2	61.9
New Mexico----------------	81.3	67.3
Texas--------------------	76.5	57.0

Source: 1977 National Resource Inventories (USDA, 1978)

Wetness.--Wetness may be caused by overflow or by poor surface or internal drainage that can affect plant growth and tillage. As shown in table 3A-1, there are 105 million acres of cropland soils that have a wetness limitation ("w" subclass) (USDA, 1978).

Climatic Limitations.--Table 3A-1 indicates that there are 27 million acres of cropland soils with climatic limitations that affect crop production and soil management (USDA, 1978). In addition to these 27 million acres, there are many millions of acres of other cropland that have the same climatic problem, but factors such as susceptibility to erosion are considered the dominant limitation in the land capability classification system. Climatic limitations, exemplified by periodic drought, affect crop production and soil management on most of the soils in the western three-fourths of North Dakota, South Dakota, Nebraska, Kansas, and Texas and in all states farther west. See also "Climate" in chapter 5.

Soil Limitations in the Rooting Zone.--There are 40 million acres of soils used for cropland that have soil limitations in the rooting zone (table 3A-1) (USDA, 1978). These soil limitations include shallow rooting zones, stones, droughtiness, salinity, or sodium. They affect such things as productivity, crop adaptation, and the use of farm equipment.

Flood Prone Areas.--Of the cropland, 48 million acres, or 11.7 percent, are subject to flooding (USDA, 1978). Of this total, 3 million acres are unsuited to cultivation (USDA, 1978) and should be converted to uses such as pastureland, rangeland, or forest land.

Because of the hazard to irrigation facilities such as ditches, pipelines, sprinklers, and pumps, flooding of irrigated cropland can cause more damage than flooding of nonirrigated land. Of the flood prone cropland, 9.5 million acres are irrigated. This is 16.6 percent of all irrigated land, 19.8 percent of all flood prone cropland, and 2.3 percent of all cropland.

Trends

There were approximately 522 million acres of cropland in 1929 and 531 million in 1939 (USDC, 1978). In 1958, 1967, and 1977 there were approximately 449, 438, and 413 million acres, respectively (USDA, 1962, 1971, 1978). Since 1939, the trend in cropland acreage has been downward. Increasing yields per acre have made it possible to produce food and fiber for a growing population on fewer acres. Also, the quality of cropland has been improved by shifting the most erodible cropland to other land uses and converting land in capability classes I-III from other uses to cropland.

Compared to the 37 million acres in 1958, irrigated cropland acreage had increased by 20.3 percent in 1967, and by 56.5 percent in 1977.

Tables 3A-6 to 19 follow. Tables 6 to 18 relate to cropland erosion. Tables 3A-19a, b, and c list major irrigated crops by types of irrigation.

Table 3A-6.--Cropland in wind erosion groups, by major crops in the Great Plains States 1/, 1977

Crop	Erosion groups, tons/acre/year <5	5-10	>10
	(Percentage)		
Corn------------	66	14	20
Soybeans--------	58	16	26
Cotton----------	10	15	75
Sorghum---------	40	19	41
Wheat-----------	69	16	15

1/ Colorado, Kansas, Montana, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming.

Table 3A-7.--Irrigated cropland in wind erosion groups, by major crops in the Great Plains States, 1/ 1977

Crop	Erosion groups, tons/acre/year <5	5-10	>10
	(Percentage)		
Corn------------	53	17	30
Soybeans--------	33	22	45
Cotton----------	8	14	78
Sorghum---------	30	20	50

1/ Colorado, Kansas, Montana, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming.

Table 3A-8.--Cropland in sheet and rill erosion groups by major crops, 1977 (United States and the Caribbean area, excluding Alaska)

Crop	Erosion groups, tons/acre/year		
	<5	5-10	>10
		(Percentage)	
Corn-------------	67	17	16
Soybeans---------	56	26	18
Cotton-----------	66	22	12
Sorghum----------	61	23	16
Wheat------------	87	9	4
Peanuts----------	53	32	15
Tobacco----------	47	26	27

Table 3A-9.--Irrigated cropland in sheet and rill erosion groups, by major crops, 1977 (United States and the Caribbean area, excluding Alaska)

Crop	Erosion groups, tons/acre/year		
	<5	5-10	>10
		(Percentage)	
Corn------------	77	11	12
Soybeans--------	52	27	21
Cotton----------	74	18	8
Sorghum---------	67	23	10

Table 3A-10.--Cropland of the Great Plains States by major crops having a wind erosion rate greater than 5 tons/acre/year, 1977

State	Corn	Sorghum	Soybeans	Cotton	Wheat
			(1,000 acres)		
Colorado-------	305	322	---	---	1,793
Kansas---------	364	887	15	---	2,365
Montana--------	8	5	---	---	1,413
Nebraska-------	497	53	33	---	333
New Mexico-----	115	265	---	120	513
North Dakota --	59	---	53	---	952
Oklahoma-------	---	202	---	299	1,286
South Dakota---	499	104	48	---	864
Texas----------	915	3,181	200	6,562	2,711
Wyoming--------	36	---	---	---	319
Total-----	2,798	5,019	349	6,981	12,549

Table 3A-11.--Cropland of the Great Plains States 1/, by major crops having a wind erosion rate greater than 5 tons/acre/year, by land capability subclass, 1977

Land capability subclass	Corn	Sorghum	Soybeans	Cotton	Wheat
	(1,000 acres)				
I	216	125	39	220	381
IIc	67	253	---	647	843
IIe	662	604	68	1,208	1,849
IIs	554	954	116	752	616
IIw	49	159	17	42	232
IIIc	---	236	---	---	955
IIIe	512	1,185	10	2,537	4,358
IIIs	57	143	6	154	204
IIIw	31	111	71	118	68
IVc	---	59	---	25	---
IVe	453	740	7	807	2,169
IVs	54	36	15	80	130
IVw	10	49	---	30	14
Vw	5	36	---	---	15
VIc	---	---	---	74	---
VIe	94	263	---	242	550
VIs	---	13	---	15	57
VIw	---	31	---	10	16
VIIe	34	---	---	10	43
VIIs	---	22	---	---	49
VIIw	---	---	---	10	---
Total	2,798	5,019	349	6,981	12,549

1/ Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming

Table 3A-12.--Wind erosion of cropland in corn in the Great Plains States by erosion groups, 1977

State	Erosion groups, tons/acre/year			
	<2	2-4.9	5-10	>10
	(1,000 acres)			
Colorado	117	116	117	188
Kansas	371	223	104	260
Montana	---	---	---	8
Nebraska	845	348	253	244
New Mexico	13	32	27	88
North Dakota	242	148	52	7
South Dakota	1,372	1,332	336	163
Texas	75	104	235	680
Wyoming	10	9	27	9
Total	3,045	2,312	1,151	1,647

Table 3A-13.--Wind erosion of cropland in sorghum in the Great Plains States by erosion groups, 1977

State	Erosion groups, tons/acre/year			
	<2	2-4.9	5-10	>10
	(1,000 acres)			
Colorado	97	59	82	240
Kansas	773	500	416	471
Montana	---	---	---	5
Nebraska	369	100	23	30
New Mexico	79	96	94	171
Oklahoma	47	147	63	139
South Dakota	215	218	100	4
Texas	322	357	807	2,374
Total	1,902	1,477	1,585	3,434

Table 3A-14.--Wind erosion of cropland in soybeans in the Great Plains States by erosion groups, 1977

State	Erosion groups, tons/acre/year			
	<2	2-4.9	5-10	>10
	(1,000 acres)			
Kansas----------------------	8	30	---	15
Nebraska--------------------	29	7	8	25
North Dakota----------------	59	18	53	---
Oklahoma--------------------	---	8	---	---
South Dakota----------------	147	154	40	8
Texas-----------------------	---	25	35	165
Total------------------	243	242	136	213

Table 3A-15.--Wind erosion of cropland in cotton in Great Plains States, by erosion groups, 1977

State	Erosion groups, tons/acre/year			
	<2	2-4.9	5-10	>10
	(1,000 acres)			
New Mexico--------------	6	44	53	67
Oklahoma----------------	107	106	133	166
Texas-------------------	214	272	961	5,601
Total--------------	327	422	1,147	5,834

Table 3A-16.--Wind erosion of cropland in wheat in the Great Plains States, 1977

State	Erosion groups, tons/acre/year			
	<2	2-4.9	5-10	>10
	(1,000 acres)			
Colorado	366	809	562	1,231
Kansas	4,176	2,225	1,523	842
Montana	1,955	1,728	621	792
Nebraska	887	587	221	112
New Mexico	36	91	216	297
North Dakota	4,746	2,354	860	92
Oklahoma	2,234	1,049	817	469
South Dakota	1,131	1,496	654	210
Texas	952	683	937	1,774
Wyoming	97	104	182	137
Total	16,580	11,126	6,593	5,956

Table 3A-17.--Cropland by major crops and by states with an annual sheet and rill erosion rate greater than 5 tons/acre/year, 1977

State	Corn	Sorghum	Soybeans	Cotton	Wheat	Peanuts
			(1,000 acres)			
Alabama----------	648	23	1,012	395	15	179
Arizona----------	----	----	----	----	1	----
Arkansas---------	29	121	2,722	779	5	----
California-------	4	----	----	----	13	----
Colorado---------	101	118	----	----	395	----
Connecticut------	39	----	----	----	----	----
Delaware---------	41	----	18	----	2	----
Florida----------	285	67	165	----	----	48
Georgia----------	1,334	57	681	94	3	281
Hawaii-----------	3	----	----	----	----	----
Idaho------------	3	----	----	----	263	----
Illinois---------	4,892	79	2,815	----	483	----
Indiana----------	1,993	10	1,314	----	297	----
Iowa-------------	7,252	67	3,215	----	----	----
Kansas-----------	399	1,701	652	----	1,894	----
Kentucky---------	780	14	736	----	27	----
Louisiana--------	68	27	1,691	636	----	----
Maine------------	33	----	----	----	----	----
Maryland---------	331	8	112	----	7	----
Massachusetts----	28	----	----	----	----	----
Michigan---------	668	----	43	----	79	----
Minnesota--------	1,183	----	555	----	127	----
Mississippi------	267	35	2,418	1,167	5	----
Missouri---------	2,033	989	2,931	165	713	----
Montana----------	----	----	----	----	293	----
Nebraska---------	1,995	793	458	----	614	----
New Hampshire----	6	----	----	----	----	----
New Jersey-------	71	----	122	----	3	----
New Mexico-------	----	58	----	----	34	----
New York---------	701	11	4	----	57	----
North Carolina---	875	7	750	34	51	16
North Dakota-----	35	----	----	----	957	----
Ohio-------------	696	7	638	----	233	----
Oklahoma---------	36	355	372	250	1,352	36
Oregon-----------	----	----	----	----	110	----
Pennsylvania-----	984	15	92	----	57	----
Rhode Island-----	5	----	----	----	----	----
South Carolina---	252	19	413	91	4	3
South Dakota-----	571	159	58	----	306	----
Tennessee--------	560	37	1,633	268	27	4
Texas------------	220	2,298	346	1,669	406	189
Utah-------------	----	----	----	----	1	----
Vermont----------	25	----	----	----	----	----
Virginia---------	411	25	218	----	10	35

Table 3A-17.--Cropland by major crops and by states with an annual sheet and rill erosion rate greater than 5 tons/acre/year, 1977--Continued

State	Corn	Sorghum	Soybeans	Cotton	Wheat	Peanuts
			(1,000 acres)			
Washington------	----	----	----	----	234	----
West Virginia---	58	----	----	----	----	----
Wisconsin-------	1,405	----	105	----	13	----
Wyoming---------	----	----	----	----	102	----
Puerto Rico-----	6	----	----	----	----	----
Total-------	31,326	7,100	26,289	5,548	9,193	791

Table 3A-18a.--Sheet and rill erosion of cropland by erosion groups, states, and major crops, 1977

	Corn				Sorghum				Soybeans				Cotton			
	Erosion groups, tons/acre/year				Erosion groups, tons/acre/year				Erosion groups, tons/acre/year				Erosion groups, tons/acre/year			
	<2	2-5	5-10	>10	<2	2-5	5-10	>10	<2	2-5	5-10	>10	<2	2-5	5-10	>10
	(1,000 acres)															
Alabama--------	101	282	365	283	10	7	----	23	139	501	554	458	15	66	148	247
Arizona--------	20	4	----	----	38	4	----	----	----	----	----	----	698	5	----	----
Arkansas-------	----	25	11	18	----	47	91	30	120	2,055	2,114	613	20	505	560	219
California-----	506	----	----	4	----	----	----	----	----	----	----	----	1,542	----	----	----
Colorado-------	671	321	85	16	319	200	78	40	----	----	----	----	----	----	----	----
Connecticut----	17	20	14	25	----	----	----	----	----	----	----	----	----	----	----	----
Delaware-------	68	116	26	15	3	----	----	----	115	128	11	7	----	----	----	----
Florida--------	109	175	189	96	24	9	58	9	39	99	79	86	----	----	----	----
Georgia--------	422	1,050	826	508	20	10	20	37	130	511	410	271	----	109	66	28
Hawaii---------	---	1	3	---	----	----	----	----	----	----	----	----	----	----	----	----
Idaho----------	168	7	3	---	----	----	----	----	----	----	----	----	----	----	----	----
Illinois--------	3,073	4,708	2,908	2,005	42	41	30	49	1,682	3,155	1,667	1,148	----	----	----	----
Indiana---------	2,400	2,615	1,132	861	3	15	10	----	1,121	1,576	885	429	----	----	----	----
Iowa-----------	2,480	4,669	2,971	4,303	7	29	29	38	1,463	2,825	1,459	1,756	----	----	----	----
Kansas----------	519	1,393	291	108	1,085	1,932	994	715	84	482	474	178	----	----	----	----
Kentucky--------	397	568	356	428	7	----	5	9	215	333	371	365	----	----	----	----
Louisiana-------	----	48	42	26	----	11	15	12	158	1,263	1,353	338	17	87	386	250
Maine-----------	35	32	13	20	----	----	----	----	----	----	----	----	----	----	----	----
Maryland--------	204	337	180	151	9	----	8	----	78	142	73	39	----	----	----	----
Massachusetts---	9	17	18	10	----	----	----	----	----	----	----	----	----	----	----	----
Michigan--------	1,978	927	421	247	30	7	----	----	523	141	14	29	----	----	----	----
Minnesota-------	3,879	2,045	741	442	15	8	----	----	1,857	1,024	317	238	----	----	----	----
Mississippi-----	20	105	125	142	11	7	10	25	272	1,473	1,277	1,141	61	551	603	571
Missouri--------	340	1,033	885	1,148	124	296	405	584	232	1,586	1,469	1,462	30	172	150	15
Montana---------	50	----	----	----	5	----	----	----	----	----	----	----	----	----	----	----
Nebraska--------	2,794	2,933	774	1,229	502	1,018	281	512	155	412	185	273	----	----	----	----
Nevada----------	8	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
New Hampshire---	11	11	3	3	----	----	----	----	----	----	----	----	----	----	----	----
New Jersey------	70	34	29	42	1	----	----	----	30	36	83	39	----	----	----	----
New Mexico------	96	78	----	----	156	229	29	29	----	----	----	----	117	65	----	----
New York--------	561	566	332	375	----	8	----	11	----	----	4	----	----	----	----	----

Table 3A-18a.--Sheet and rill erosion of cropland by erosion groups, states, and major crops, 1977--Continued

	Corn				Sorghum				Soybeans				Cotton			
	Erosion groups, tons/acre/year				Erosion groups, tons/acre/year				Erosion groups, tons/acre/year				Erosion groups, tons/acre/year			
	<2	2-5	5-10	>10	<2	2-5	5-10	>10	<2	2-5	5-10	>10	<2	2-5	5-10	>10
	(1,000 acres)															
North Carolina--	572	1,041	426	456	7	22	----	7	464	539	402	348	28	7	20	14
North Dakota----	481	178	18	17	40	----	----	----	123	17	----	----	----	----	----	----
Ohio-----------	1,735	1,512	422	274	----	5	----	7	1,344	1,392	411	227	----	----	----	----
Oklahoma--------	63	22	22	14	292	261	229	126	52	147	241	131	82	255	195	55
Oregon----------	83	7	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pennsylvania----	597	534	470	522	----	8	8	7	----	6	42	56	----	----	----	----
Rhode Island----	----	----	2	3	----	----	----	----	----	----	----	----	----	----	----	----
South Carolina--	218	580	194	58	14	19	14	51	238	661	282	131	4	97	61	30
South Dakota----	1,429	1,416	315	256	213	204	69	90	173	147	39	19	----	----	----	----
Tennessee-------	121	206	228	332	----	21	8	29	172	488	705	928	----	10	63	205
Texas-----------	523	1,025	176	44	847	2,770	1,878	420	70	381	332	14	2,335	4,131	1,364	305
Utah------------	98	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Vermont---------	23	31	13	12	----	3	----	----	----	----	----	----	----	----	----	----
Virginia--------	293	370	173	238	6	6	6	19	138	222	101	117	----	----	----	----
Washington------	207	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
West Virginia---	63	66	30	28	----	----	----	----	----	----	----	----	----	----	----	----
Wisconsin-------	1,861	1,440	827	585	8	8	----	----	57	43	45	60	----	----	----	----
Wyoming---------	110	4	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Puerto Rico-----	----	----	----	6	----	----	----	----	----	----	----	----	----	----	----	----
Total-------	29,483	32,552	16,059	15,350	3,838	7,205	4,275	2,833	11,244	21,785	15,399	10,901	4,966	6,060	3,616	1,939

Table 3A-18b.--Sheet and rill erosion of cropland, by erosion groups, states, and major crops, 1977

	Tobacco				Wheat				Peanuts			
	Erosion groups, tons/acre/year				Erosion groups, tons/acre/year				Erosion groups, tons/acre/year			
	<2	2-5	5-10	>10	<2	2-5	5-10	>10	<2	2-5	5-10	>10
	(1,000 acres)											
Alabama----------	----	----	----	----	----	----	----	15	16	133	112	67
Arizona----------	----	----	----	----	68	1	1	----	----	----	----	----
Arkansas---------	----	----	----	----	21	6	5	----	----	----	----	----
California-------	----	----	----	----	286	14	13	----	----	----	----	----
Colorado---------	----	----	----	----	1,868	1,239	246	149	----	----	----	----
Connecticut------	7	3	----	----	----	----	----	----	----	----	----	----
Delaware---------	----	----	----	----	2	----	2	----	1	1	----	----
Florida----------	14	----	21	----	----	----	----	----	----	8	28	20
Georgia----------	4	27	51	45	7	----	----	3	123	227	171	110
Idaho------------	----	----	----	----	938	332	149	114	----	----	----	----
Illinois---------	----	----	----	----	279	538	243	240	----	----	----	----
Indiana----------	----	----	----	----	321	272	212	85	----	----	----	----
Iowa-------------	----	----	----	----	45	30	----	----	----	----	----	----
Kansas-----------	7	8	15	----	6,125	5,219	1,362	532	----	----	----	----
Kentucky---------	57	93	57	70	9	6	20	7	----	----	----	----
Maryland---------	4	3	6	17	28	14	7	----	----	----	----	----
Michigan---------	----	----	----	----	504	278	50	29	----	----	----	----
Minnesota--------	----	----	----	----	2,812	430	98	36	----	----	----	----
Mississippi------	----	----	----	----	5	17	----	5	7	----	----	----
Missouri---------	----	----	----	----	181	305	225	488	----	----	----	----
Montana----------	----	----	----	----	4,965	744	221	72	----	----	----	----
Nebraska---------	----	20	----	----	1,648	883	311	303	----	----	----	----
Nevada-----------	----	----	----	----	21	----	----	----	----	----	----	----
New Jersey-------	----	----	----	----	24	----	3	----	----	----	----	----
New Mexico-------	----	----	----	----	419	211	27	7	9	6	----	----
New York---------	----	----	----	----	51	43	44	13	----	----	----	----
North Carolina----	65	263	209	185	11	39	34	17	55	113	16	----
North Dakota------	----	----	----	----	6,519	2,361	756	201	----	----	----	----
Ohio-------------	8	7	----	----	785	397	139	94	----	----	----	----
Oklahoma---------	----	----	----	----	2,863	3,457	1,050	316	10	20	36	----
Oregon-----------	----	----	----	----	977	227	80	30	----	----	----	----

Table 3A-18b.--Sheet and rill erosion of cropland, by erosion groups, states, and major crops, 1977--Continued

State	Tobacco				Wheat				Peanuts			
	Erosion groups, tons/acre/year				Erosion groups, tons/acre/year				Erosion groups, tons/acre/year			
	<2	2-5	5-10	>10	<2	2-5	5-10	>10	<2	3-5	5-10	>10
	(1,000 acres)											
Pennsylvania-----	----	7	7	----	47	57	28	29	----	----	----	----
South Carolina---	19	62	7	7	5	----	----	4	----	10	3	----
South Dakota-----	---	----	----	----	2,598	867	207	99	----	----	----	----
Tennessee--------	36	25	18	33	----	11	5	22	----	----	4	----
Texas------------	----	----	----	----	4,348	1,649	353	53	10	74	138	51
Utah-------------	----	----	----	----	258	21	1	----	----	----	----	----
Virginia---------	18	27	48	84	50	29	----	10	42	22	23	12
Washington-------	----	----	----	----	2,310	660	219	15	----	----	----	----
West Virginia----	----	5	----	----	3	3	----	----	----	----	----	----
Wisconsin--------	----	----	----	8	18	23	4	9	----	----	----	----
Wyoming----------	----	----	----	----	402	199	63	39	----	----	----	----
Total-------	239	550	439	449	41,821	20,582	6,178	3,036	273	614	531	260

Table 3A-19a.--Major irrigated crops by types of irrigation systems, by states, 1977

State	Wheat			Sorghum			Sugar Beets		
	Gravity	Pressure	Gravity and pressure	Gravity	Pressure	Gravity and pressure	Gravity	Pressure	Gravity and pressure
					(1,000 acres)				
Arizona------------	66	----	2	31	11	----	19	----	----
Arkansas-----------	----	----	----	11	----	----	---	----	----
California---------	109	25	26	----	---	----	169	51	15
Colorado-----------	31	106	----	143	53	----	58	----	----
Florida------------	----	----	----	----	43	----	----	----	----
Idaho--------------	178	355	17	----	----	----	30	106	12
Kansas-------------	354	83	8	333	278	8	46	----	----
Michigan-----------	----	7	----	----	----	----	----	----	----
Minnesota----------	----	45	----	----	7	----	----	23	----
Missouri-----------	----	8	----	31	45	16	----	----	----
Montana------------	64	130	41	5	----	----	39	----	8
Nebraska-----------	23	77	----	164	74	----	57	19	----
Nevada-------------	8	13	----	----	----	----	----	----	----
New Jersey---------	----	----	----	----	1	----	----	----	----
New Mexico---------	103	33	----	119	77	----	----	----	----
Oklahoma-----------	66	101	7	70	104	----	----	----	----
Oregon-------------	77	136	----	----	----	----	69	5	----
South Dakota-------	8	7	----	---	----	----	----	----	----
Texas--------------	909	351	20	930	161	10	30	----	----
Utah---------------	36	17	----	----	----	----	5	2	----
Virginia-----------	----	----	----	----	6	----	----	----	----
Washington---------	97	435	38	----	----	----	33	12	----
Wyoming------------	35	58	----	----	----	----	22	2	----
Total---------	2,164	1,987	159	1,837	860	34	577	220	35

Table 3A-19b.--Major irrigated crops by types of irrigation systems by states, 1977

State	Corn			Cotton			Soybeans		
	Gravity	Pressure	Gravity and pressure	Gravity	Pressure	Gravity and pressure	Gravity	Pressure	Gravity and pressure
	(1,000 acres)								
Alabama------------	----	14	----	----	----	----	----	8	----
Arizona------------	21	----	3	703	----	----	----	----	----
Arkansas-----------	----	----	23	78	27	58	1,134	43	213
California---------	418	26	66	1,098	220	224	----	----	----
Colorado-----------	626	273	156	----	----	----	----	----	----
Delaware-----------	----	12	----	----	----	----	----	13	----
Florida------------	15	61	----	----	----	----	----	6	----
Georgia------------	----	201	----	----	----	----	----	72	----
Hawaii-------------	----	4	----	----	----	----	----	----	----
Idaho--------------	135	34	9	----	----	----	----	----	----
Illinois-----------	7	30	----	----	----	----	14	----	----
Indiana------------	----	84	----	----	----	----	----	26	----
Iowa---------------	37	38	----	----	----	----	----	----	----
Kansas-------------	985	686	7	----	----	----	23	21	7
Louisiana----------	8	----	----	----	----	----	382	8	10
Maine--------------	----	4	----	----	----	----	----	----	----
Maryland-----------	----	6	----	----	----	----	----	----	----
Michigan-----------	----	88	----	----	----	----	----	----	----
Minnesota----------	----	228	----	----	----	----	----	37	----
Mississippi--------	8	23	----	41	----	71	20	----	112
Missouri-----------	55	148	46	----	47	39	140	92	47
Montana------------	47	3	----	----	----	----	----	----	----
Nebraska-----------	3,133	2,071	67	----	----	----	159	62	----
Nevada-------------	8	----	----	----	----	----	----	----	----
New Jersey---------	----	2	----	----	----	----	----	14	----
New Mexico---------	146	28	----	143	21	----	----	----	----
New York-----------	----	12	----	----	----	----	----	----	----
North Carolina-----	----	57	----	----	----	----	----	36	----
North Dakota-------	8	52	----	----	----	----	----	----	----

Table 3A-19b.--Major irrigated crops by types of irrigation systems by states, 1977--Continued

State	Corn			Cotton			Soybeans		
	Gravity	Pressure	Gravity and pressure	Gravity	Pressure	Gravity and pressure	Gravity	Pressure	Gravity and pressure
					(1,000 acres)				
Ohio---------------	----	5	----	----	----	----	----	7	----
Oklahoma-----------	63	----	----	30	----	15	----	31	----
Oregon-------------	39	31	20	----	----	----	----	----	----
South Carolina-----	----	5	----	----	----	----	----	24	----
South Dakota-------	32	162	----	----	----	----	10	23	----
Texas--------------	1,164	193	15	1,723	839	44	186	20	----
Utah---------------	95	3	----	----	----	----	----	----	----
Virginia-----------	----	----	----	----	----	----	----	10	----
Washington---------	74	94	----	----	----	----	----	----	----
Wisconsin----------	----	157	----	----	----	----	----	15	----
Wyoming------------	67	30	----	----	----	----	----	----	----
Total---------	7,191	4,865	412	3,816	1,154	451	2,068	568	389

Table 3A-19c.--Major irrigated crops by types of irrigation, by states, 1977

State	Rice			Peanuts			Potatoes		
	Gravity	Pressure	Gravity and pressure	Gravity	Pressure	Gravity and pressure	Gravity	Pressure	Gravity and pressure
					(1,000 acres)				
Alabama----------------	----	----	----	----	15	----	----	----	----
Arkansas---------------	729	14	96	----	----	----	----	----	----
California-------------	373	----	----	----	----	----	7	127	----
Colorado---------------	----	----	----	----	----	----	31	24	----
Connecticut------------	----	----	----	----	----	----	----	3	----
Delaware---------------	----	----	----	----	----	----	----	2	----
Florida----------------	----	----	----	----	----	----	58	----	----
Georgia----------------	----	----	----	----	226	----	----	----	----
Idaho------------------	----	----	----	----	----	----	19	347	8
Louisiana--------------	557	----	21	----	----	----	----	----	----
Maine------------------	----	----	----	----	----	----	----	3	----
Michigan---------------	----	----	----	----	----	----	----	44	----
Minnesota--------------	5	----	----	----	----	----	----	36	7
Mississippi------------	31	23	20	----	----	----	----	----	----
Missouri---------------	16	----	----	----	----	----	----	----	---
Nebraska---------------	----	----	----	----	----	----	----	30	----
Nevada-----------------	----	----	----	----	----	----	----	42	----
New Jersey-------------	----	----	----	----	----	----	----	5	----
New Mexico-------------	----	----	----	----	15	----	----	----	----
New York---------------	----	----	----	----	----	----	----	31	----
North Carolina---------	----	----	----	----	----	----	----	7	----
Ohio-------------------	----	----	----	----	----	----	----	14	----
Oklahoma---------------	----	----	----	----	41	----	----	----	----
Oregon-----------------	----	----	----	----	----	----	3	35	----
Texas------------------	674	----	9	----	100	----	10	----	----
Utah-------------------	----	----	----	----	----	----	2	1	----
Washington-------------	----	----	----	----	----	----	----	104	----
Wisconsin--------------	----	----	----	----	----	----	----	56	----
Wyoming----------------	----	----	----	----	----	----	2	2	----
Total-----------	2,385	37	146	----	397	----	132	913	15

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Section B-Pastureland

Status

Pastureland is used primarily for the production of domesticated forage plants for livestock (USDA, 1978a). The forage is generally a perennial grass or a mixture of one perennial grass and one or more legumes.

In 1977, there were 116 million acres of pastureland in the United States (excluding Alaska) and the Caribbean (USDA, 1978b). This was 13.7 percent more than the 102 million acres in 1967. Table 3B-1 gives the 1977 pastureland acreage by capability class and subclass.

In 1977, there were 4.8 million acres of irrigated pastureland. This was 4.1 percent of the total amount of pastureland.

Soil Problems

Sheet and Rill Erosion.--Pastureland, when properly managed to produce adequate forage and properly grazed to maintain plant and animal vigor, normally does not have a sheet and rill erosion problem. The vegetation keeps rain drops from splashing the soil and protects the soil against excessive soil movement by runoff.

If the vegetative cover on pastureland is seriously depleted through overgrazing, close mowing for hay, drought, insect damage, or other factors, the soil becomes susceptible to erosion. In local areas and on individual farms, soil erosion on pastureland can be a problem. Nationally, the average annual soil erosion on the 20 million acres of steep and erodible land is more than 5 tons per acre. Because of severe limitations, 9 million acres of this land are not suited to use as pastureland. Table 3B-1 gives the estimated average annual sheet and rill erosion on pastureland.

Wind Erosion.--Wind erosion on pastureland is a problem only if the land is denuded of surface cover. Maltreatment of pasture to this extent is rare.

Wetness.--About 23 million acres of pastureland are affected to some degree by wetness (IIw, IIIw, IVw, V, and VIw soils, table 3B-1) (Klingebiel and Montgomery, 1973; USDA, 1978b).

Wetness affects grazing management and timeliness of fieldwork such as fertilizing and weed control. Under some conditions, the additional water on these wet soils, which would adversely affect cropland management, actually benefits forage production on pastureland.

Soil Limitations.--Limitations within the root zone of soils used for pastureland include shallow, droughty, stony, saline, or high sodium conditions. They affect productivity, species adaptation, and use of agricultural

equipment. Soils that have inherent limitations within the rooting zone make up 11.4 million acres of pastureland (table 3B-1) (USDA, 1978b).

Climate.--On about 1.3 million acres of pastureland, the soils have a climatic limitation as the primary hazard (table 3B-1) (USDA, 1978). This limitation is generally related to low rainfall that adversely affects production. Normally, pastureland is not a suitable land use in the semi-arid and arid parts of the country, unless irrigation is available.

Table 3B-1.--Estimated average annual sheet and rill erosion on pastureland, by capability class and subclass

Class and subclass	Amount (1,000 acres)	Erosion rate (tons/acre/year)
I	2,766	0.3
IIe	17,593	.7
IIw	8,505	.3
IIs	2,214	.4
IIc	830	.1
IIIe	24,340	1.6
IIIw	6,947	.3
IIIs	3,404	1.0
IIIc	192	.1
IVe	15,589	2.7
IVw	3,930	.1
IVs	3,040	1.3
IVc	128	.1
V	3,202	.3
VIe	10,939	5.8
VIw	628	0.1
VIs	2,736	3.8
VIc	105	.2
VII & VIII	8,771	10.0
Total	115,859	2.4

Source: 1977 National Resource Inventories (USDA, 1978b)

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Section C-Rangeland, Native Pasture, Alaskan Range Resources, and Tundra

Rangeland

Rangeland is defined in the 1977 SCS National Resource Inventories (NRI) (USDA, 1978a) as land on which the natural potential (climax) plant cover is principally native grasses, forbs, and shrubs valuable for forage (see glossary). It includes natural grasslands, savannahs, and certain shrub and forb lands. Except for brush control, it is managed primarily by regulating the intensity of grazing and the season of use. If the land is revegetated, the improved forage cover is managed like native vegetation. Generally this land is not fertilized, cultivated, drained, irrigated, or mechanically harvested.

Status

There are 414,116,000 acres of nonfederal rangeland in the United States and the Caribbean (Puerto Rico and the Virgin Islands). See figure 3C-1. Approximately 99 percent of the rangeland is in Alaska and the 17 western states essentially west of the 96th meridian. The other 1 percent is distributed throughout the Minnesota to Louisiana tier of states, in Florida and the Caribbean, and as marsh range across the Gulf Coast (Pendleton, 1978). See figure 3C-1.

The extent of nonfederal rangeland, by state, differs in the SCS RCA data and the FS RPA data (figure 3C-2). The variation is mainly the result of differences in agency definitions of rangeland and forest land and the interpretation of these definitions, particularly as they relate to points where forest and rangeland meet (fringe or edge). One example of a difference over definition is the pinyon-juniper plant community. In the SCS 1977 NRI, pinyon-juniper was called forest on steep shallow rocky sites where it was thought to be a component of the potential natural plant community. But where pinyon-juniper had invaded on deeper soils and gentle slopes in areas where the potential natural plant community was grassland, or it had increased substantially on savannah sites, it was called rangeland regardless of the density or canopy cover of pinyon-juniper.

The major difference in the status of nonfederal rangeland as reported in the 1967 Conservation Needs Inventory (CNI) (USDA, 1967) and the 1977 National Resource Inventories (table 3C-1, USDA, 1978a) can be attributed to the reclassification of some lands previously classified as noncommercial forest. These were natural grasslands and savannahs on which low value woody plants had invaded or increased. Some of the change was also due to conversions to and from cropland, forest, water, urban development, and other land uses. Figure 3C-3 reflects the nature of the changes in rangeland and pastureland which resulted in a net increase of 64 million acres from 1967 to 1975 (USDA, 1977).

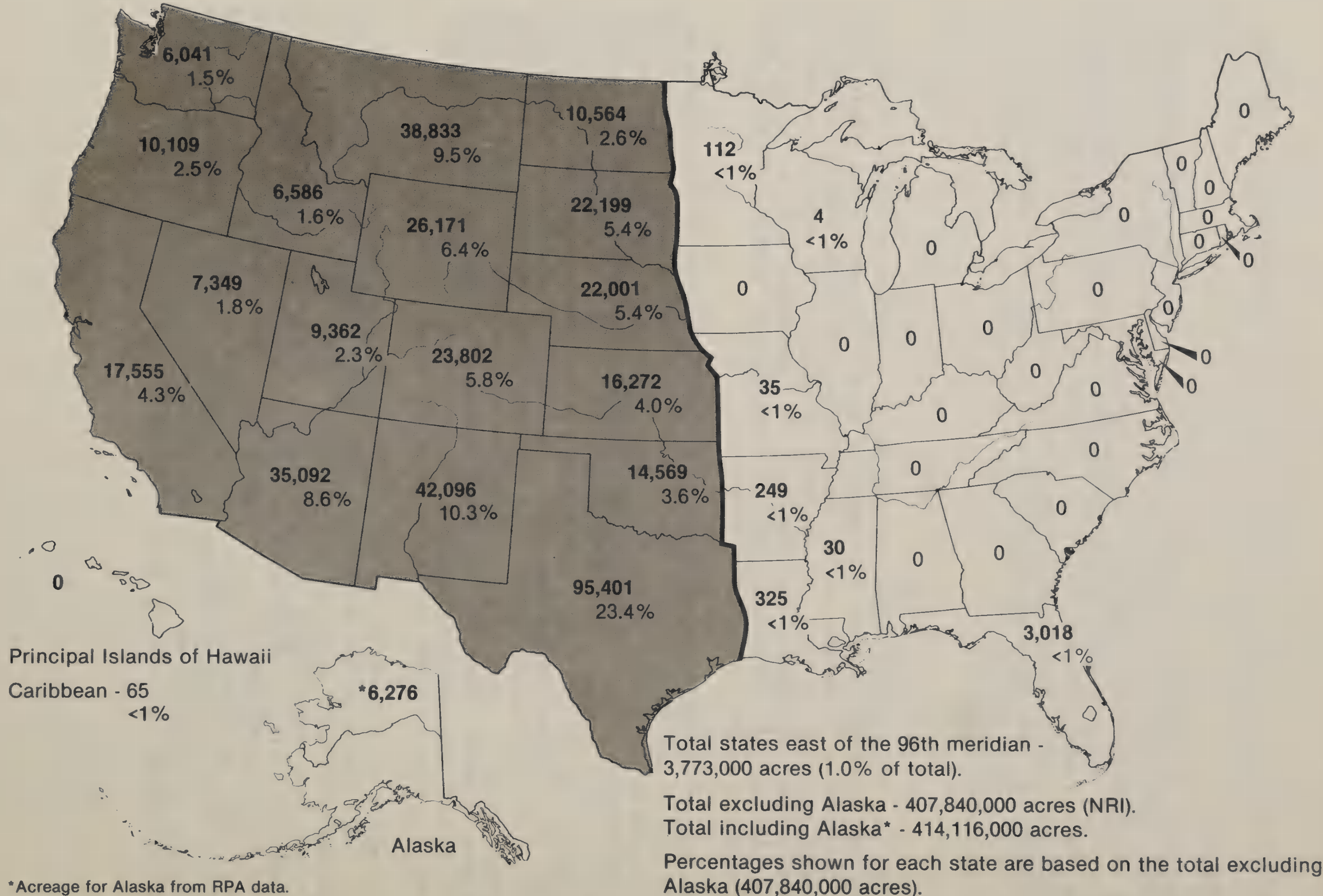


Figure 3C-1.--Acres and percentages of nonfederal rangeland, by state in 1977 (1,000 acres).

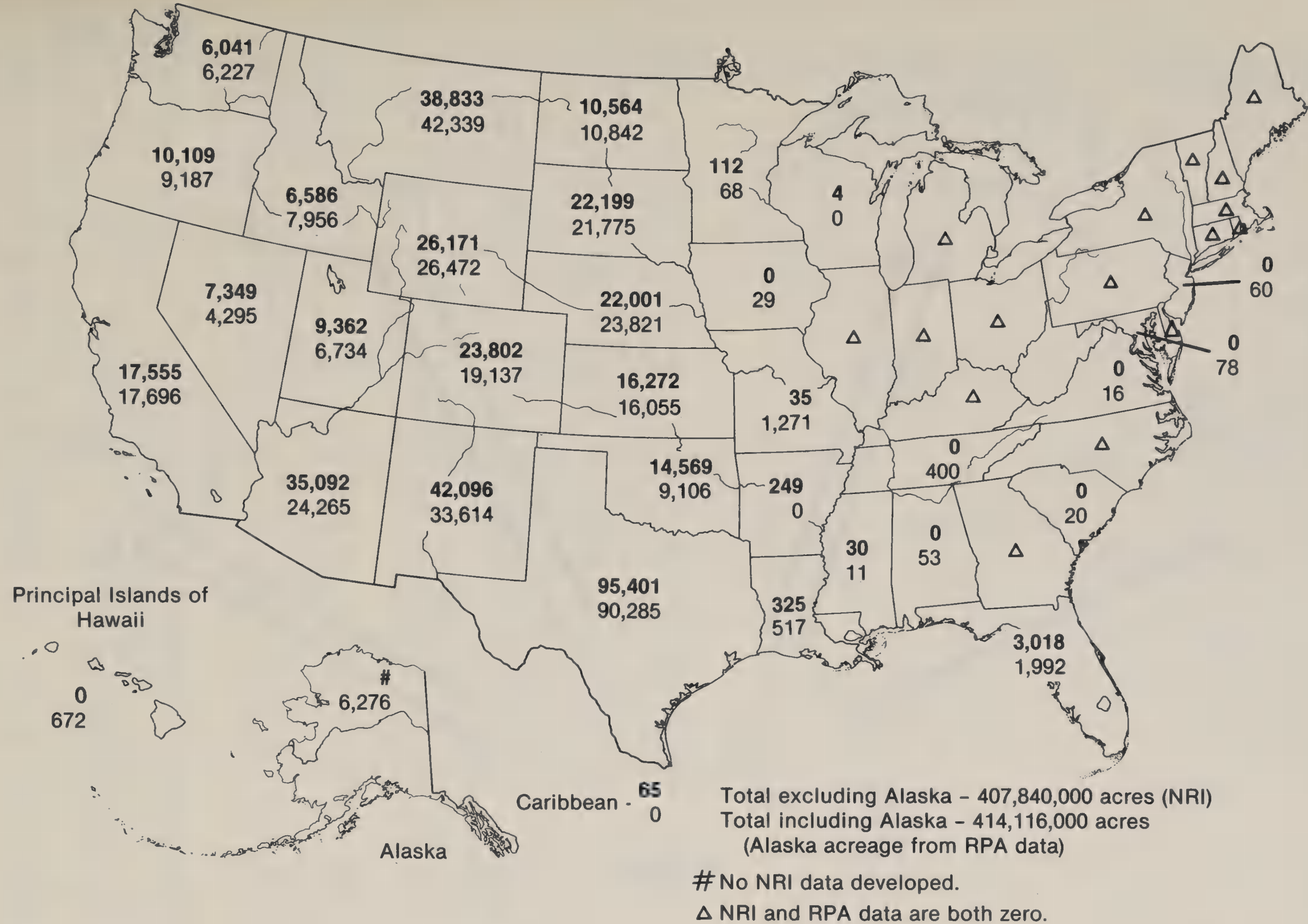


Figure 3C-2.--Acres of nonfederal rangeland (1,000 acres). SCS National Resource Inventories (NRI) figures (top) and Resources Planning Act (RPA) figures (bottom).

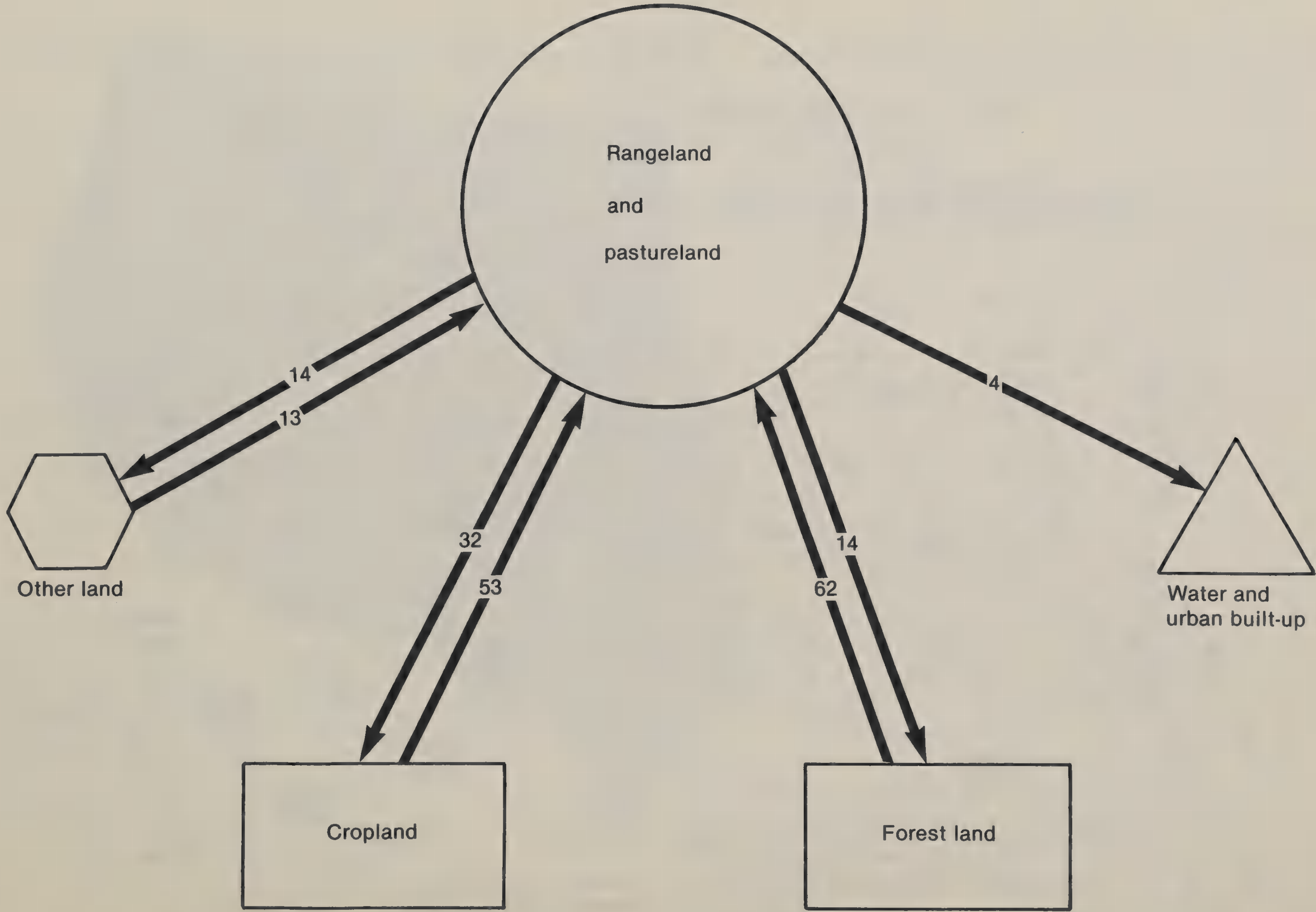


Figure 3C-3.--Rangeland and pastureland conversions, 1967 to 1975 (millions of acres). (Potential Cropland Study, 1977)

Table 3C-1.--Significant changes in the inventory of nonfederal rangeland from 1967 (CNI adjusted data) to 1977 (NRI) 1/

State	Increase		Decrease	
	Acres (1,000)	Percent	Acres (1,000)	Percent
Arizona	9,851	39	----	----
California	6,313	56	----	----
Colorado	2,511	12	----	----
Florida	1,060	54	----	----
Nevada	646	10	----	----
New Mexico	4,576	12	----	----
Texas	9,796	11	----	----
Montana	----	----	2,489	6
Nebraska	----	----	1,883	8

1/ Does not reflect changes of less than 1 million acres.

Condition

Range condition as defined by SCS (see glossary) indicates the relative degree to which the kinds and proportions of plants in the existing plant community resemble those of the presumed potential natural (or climax) plant community for the site. Any number of causes may induce a departure from the climax plant community and they may either enhance or depreciate the value of the resulting vegetation. Nevertheless, an abnormal amount of any species represents a change in range condition, regardless of the value of that species for any particular purpose. Hence, range condition does not automatically indicate the value of a plant community for food and fiber production, wildlife habitat, a watershed, or any other specific use. It merely provides a basis for predicting the direction and extent of changes likely to occur in response to specific treatment or management.

Four range condition classes are used to express the degree to which the composition of the present plant community resembles that of the climax community. They are excellent, good, fair, and poor. Excellent condition means that more than 75 percent of the present plant community is climax for the site; good condition, 51 to 75 percent is climax; fair, 26 to 50 percent; and poor, less than 25 percent.

There is usually a high degree of correlation between range condition and the overall health of the range. A site in good or excellent condition generally produces more forage and provides better habitat for native plant or animal species. It also has less erosion and maintains more of the natural soil fertility than a site in fair or poor condition.

Holland (1971) determined in a watershed study of tall grass prairie and short to midgrass prairie in Kansas that the amount of sediment in the

runoff water from rangeland doubled each time the range condition decreased one class. Sediment in runoff from tall grass prairie was the equivalent of about 0.45 ton of soil per acre from good condition range, 0.8 ton per acre from fair condition range, and 1.3 ton per acre from poor condition range. Similar rates occurred on short to midgrass rangeland where sediment rates amounted to only 0.2 ton of soil per acre from good condition range, 0.45 ton per acre from fair condition range, and 0.9 ton per acre from poor condition range. These data show that range condition relates directly to erosion and water quality. Erosion is more likely to be excessive on rangeland in poor condition. Consequently, sites in poor condition easily undergo permanent deterioration.

Rangeland in fair condition may or may not provide suitable habitat for indigenous species, particularly threatened and endangered species. Rangeland in poor condition usually yields less than 25 percent of the forage the site is capable of producing and it is frequently poor quality habitat for indigenous wildlife.

In a 1977 special study, SCS state range conservationists estimated that 12 percent of the Nation's nonfederal rangeland was in excellent or near climax condition, 28 percent in good, 42 percent in fair, and 18 percent in poor condition (figure 3C-4). In a similar range condition survey in 1963 showing state range condition (figure 3C-4), an estimated 5 percent of the nonfederal rangeland was in excellent condition, 15 percent in good condition, 40 percent in fair condition, and 40 percent in poor condition. (Unpublished Allred, 1963). Between 1963 and 1977 the percentage of range in excellent condition increased from 5 to 12 percent and the percentage in good condition increased from 15 to 28 percent, while the percentage in poor condition decreased from 40 to 18 percent (figure 3C-4). These percentages represent a substantial improvement in the 14-year period. Nevertheless, 60 percent of the nonfederal rangeland remains in fair and poor condition. The SCS results are similar to the RPA data, which indicate that 54 percent of all rangeland (federal and nonfederal) is in unsatisfactory condition (USDA, 1979). Figure 3C-5 shows the trend in range condition over the period 1963 to 1977.

The reduction in production caused by degraded range represents a loss of 30 to 40 million animal unit months (AUMs) of grazing, or a loss of 6 to 8 hundred million pounds of red meat and a significant amount of wool, mohair, leather, tallow, insulin, and many other byproducts from animal carcasses. By the year 2030, the demand for these products will increase significantly. The per capita consumption of beef and veal alone is expected to rise from 89 pounds in 1978 (calculated on weight of retail cuts) to 159 pounds in 2030. When the per capita consumption increases 1 pound at current population levels, an additional 400,000 beef cows will be required to meet the demand. By 2030, the demand for range grazing is projected to increase to 239 percent of what it was in 1976 (USDA, 1979).

Range condition varies greatly among states (figure 3C-6.) The amount of rangeland in excellent and good condition ranges from 90 percent in Louisiana to 17 percent in Nevada and Florida. The amount in poor and fair condition ranges from more than 70 percent in California, Florida, Idaho,

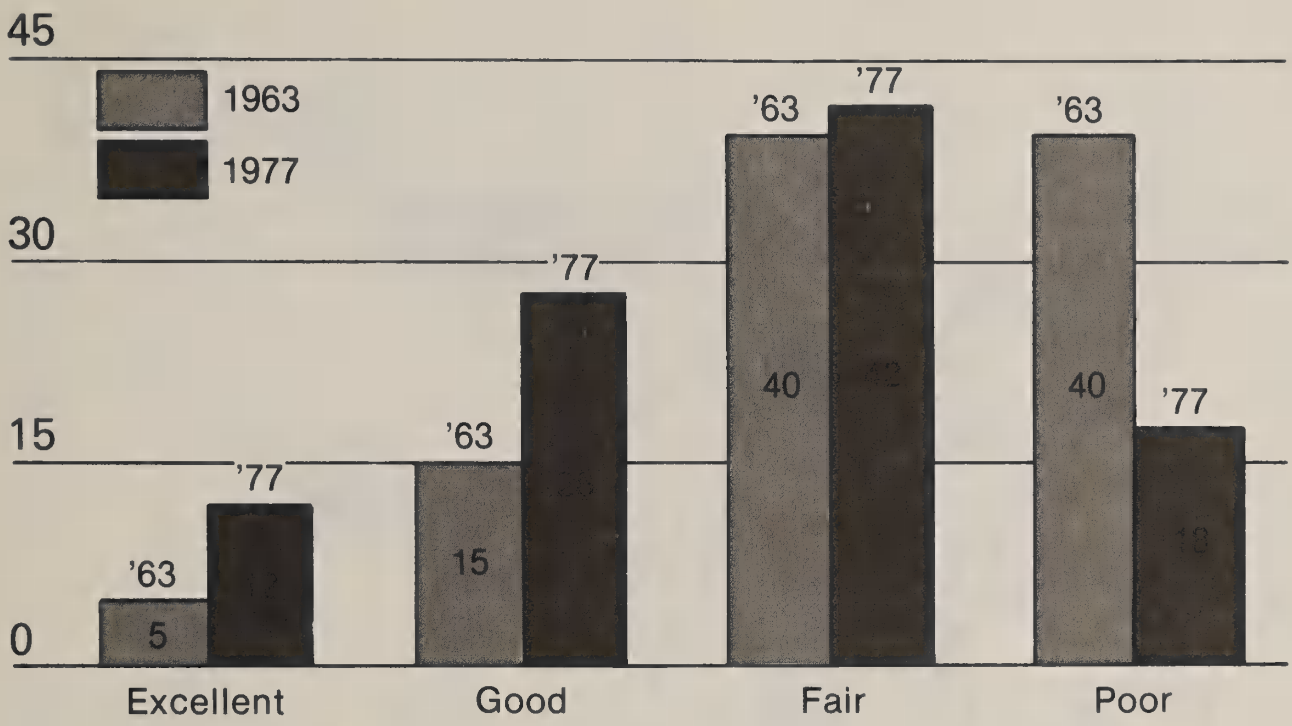


Figure 3C-4.--Percentage of nonfederal rangeland by condition, 1963 and 1977.

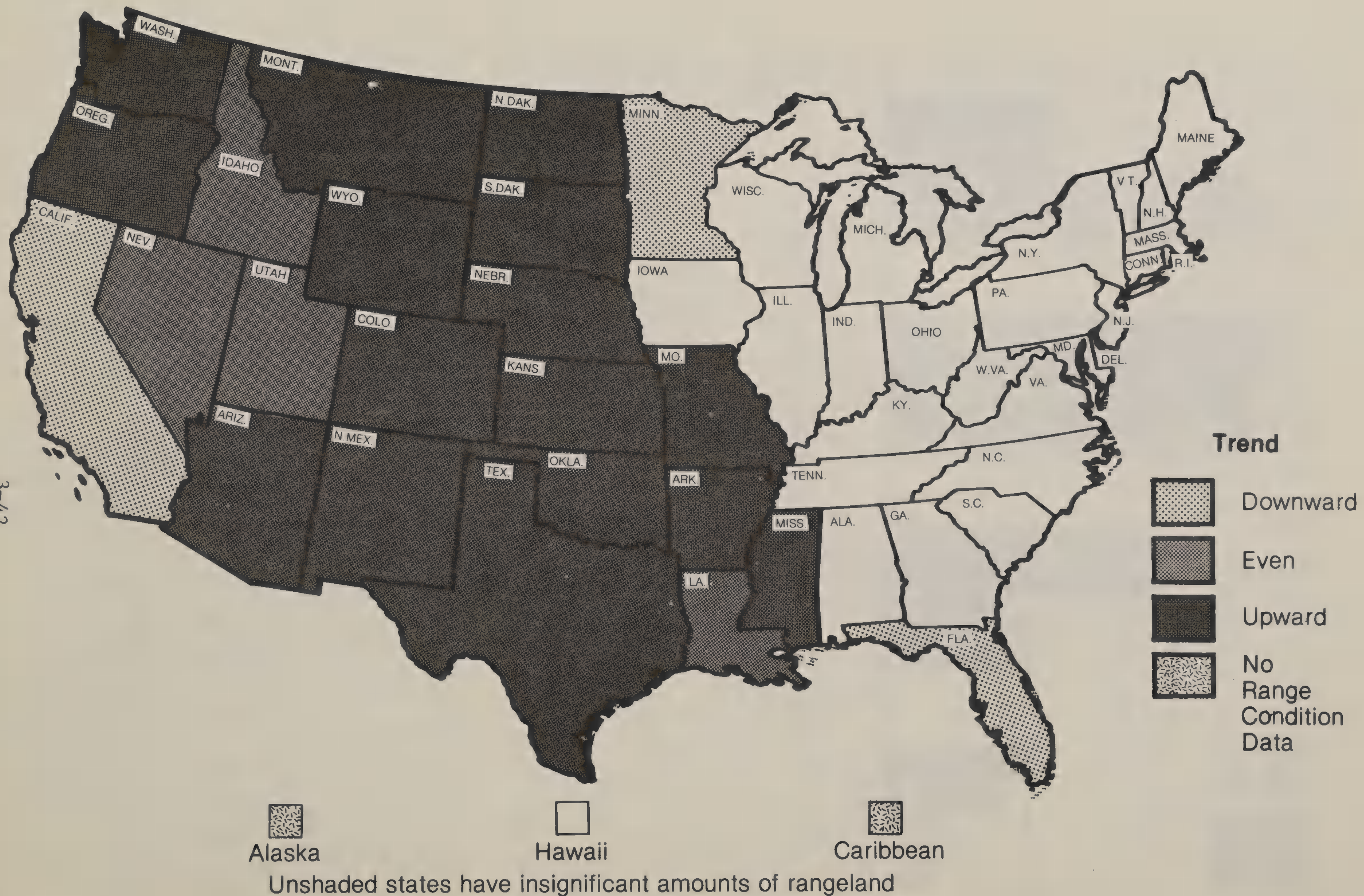


Figure 3C-5.--Trend in range condition on nonfederal rangeland, 1963 to 1977. (1963 Range Inventory by Allred)

Figure 3C-6.--Percentage of nonfederal rangeland in excellent, good, fair, and poor condition. (1977 Inventory of Nonfederal Forest and Rangeland)

Nevada, New Mexico, and Utah to 20 percent or less in Louisiana and Mississippi. California and Florida estimated that 46 percent and 62 percent of their nonfederal rangeland, respectively, was in poor condition.

The amount of rangeland estimated to be in good and excellent condition exceeded 40 percent in 11 states. Nine states had 20 to 40 percent in good and excellent condition and three states had less than 20 percent.

Data on the amount of rangeland in good and excellent condition, on the amount of rangeland in poor condition, and on trend in range condition were further analyzed to determine the overall range condition problem in each state. Three states had a severe problem, six had a major problem, and two had a moderate problem. In 12 states the problem was rated none to slight. See figure 3C-7.

The problem was rated as--

Severe if less than 20 percent of the range was in good or excellent condition or more than 40 percent was in poor condition.

Major if less than 40 percent was in good or excellent condition and more than 20 percent was in poor condition.

Moderate if 20 percent or more was in good and excellent condition and less than 20 percent was in poor condition.

None to slight if 40 percent or more was in good and excellent condition and less than 20 percent was in poor condition.

States having a downward trend in range condition were further rated down one level. For example, a moderate problem would be cited as major if the state also had a downward trend in range condition.

Soil Problems.--Since many of the soils on rangeland are shallow and have considerable slope and climatic limitations, erosion occurs readily where the land is misused. The rate and extent of erosion depends on the kind and amount of protective vegetative cover and the natural erodibility of the soils.

Wind erosion in excess of 2 tons per acre, per year occurs on V, VIc, VII, and VIII soils (table 3C-2), which account for 149,717,000 acres or 37 percent of all rangeland excluding Alaska. Sixty-eight percent of all soil removed from rangeland by wind was from these soils.

Sheet and rill erosion on rangeland in excess of 2 tons per acre, per year occurs only on VIe, VIs, VII, and VIII soils (table 3C-2). Ninety-three percent of all soil removed from rangeland by sheet and rill erosion was from these soils. These soils account for 280 million acres or 69 percent of all rangeland excluding Alaska.

Analyses of wind, sheet, and rill erosion data obtained in the 1977 National Resource Inventories (USDA, 1978a) are shown in figures 3C-8,

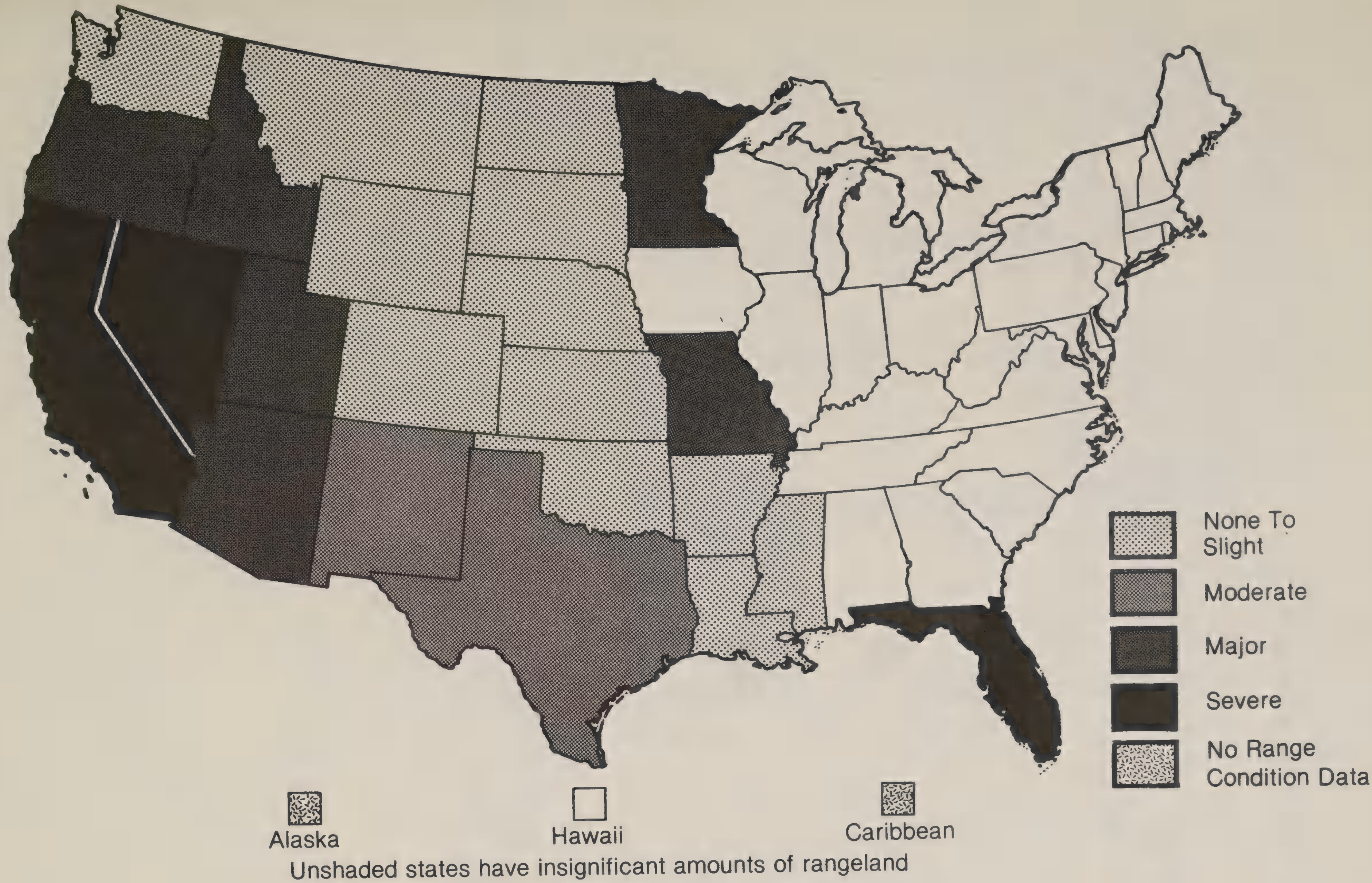


Figure 3C-7.--Range condition problems on nonfederal rangeland.

Table 3C-2.--Estimated average annual sheet and rill erosion and wind erosion

Capability class and subclass	Rangeland: Acres (1000)	Rangeland: Sheet and rill erosion (t/ac/yr)	Rangeland: Wind erosion (t/ac/yr)	Native pasture: Acres (1000)	Native pasture: Sheet and rill erosion (t/ac/yr)
I------------	745	0.47	0.01	166	1.08
IIe----------	9,738	.67	.31	1,216	.93
IIw----------	2,172	.39	.15	992	.58
IIs----------	1,420	.31	.09	258	1.65
IIc----------	3,228	.38	.02	114	.11
IIIe---------	38,199	.78	.40	2,298	2.43 1/
IIIw---------	3,638	.45	.15	1,420	.71
IIIs---------	3,164	.67	.58	560	1.10
IIIc---------	3,053	.35	.08	21	.10
IVe----------	39,171	1.21	.97	1,831	4.44 1/
IVw----------	3,291	.22	.05	1,329	.40
IVs----------	4,796	.49	.37	480	3.78 1/
IVc----------	2,530	.37	.19	16	.13
V------------	3,966	.52	2.99 2/	1,155	.37
VIe----------	106,811	2.66 1/	1.17	2,353	6.17 1/
VIw----------	4,470	.44	.60	245	.24 1/
VIs----------	31,697	2.94 1/	1.01	586	6.46 1/
VIc----------	3,920	.99	4.15 2/	14	.14
VII & VIII---	141,831	6.43 1/	3.87 2/	2,653	12.57 1/
Total---	407,840	3.41 3/	1.80 3/	17,707	4.07 3/

1/ Annual sheet and rill erosion in excess of 2 tons per acre, per year.
2/ Annual wind erosion in excess of 2 tons per acre, per year.
3/ Average annual erosion.
Source: 1977 National Resource Inventories (USDA, 1978a).

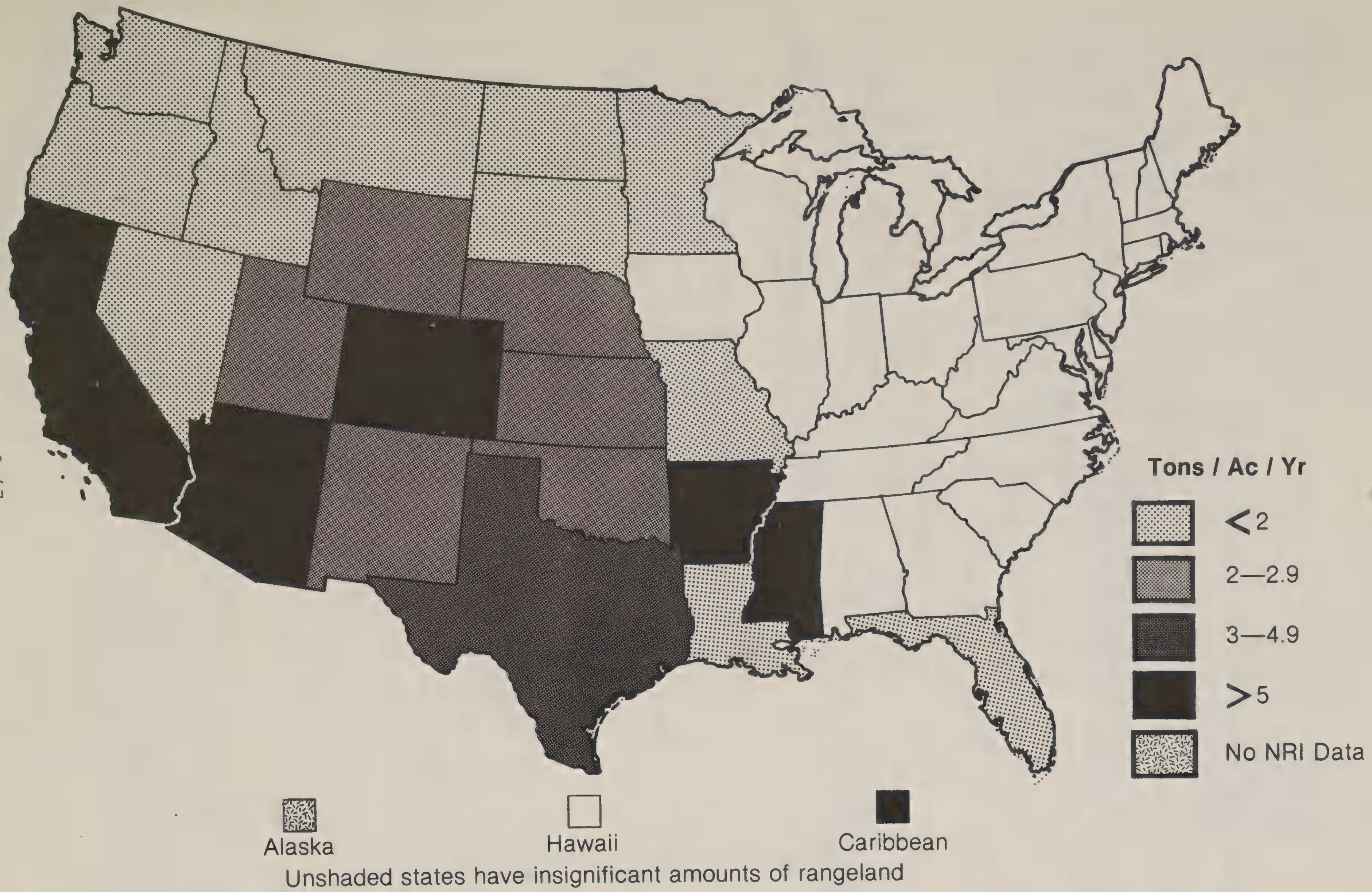


Figure 3C-8.--Sheet and rill erosion on nonfederal rangeland. (1977 National Resource Inventories)

3C-9, and 3C-10. Sheet and rill erosion rates on rangeland range from less than one ton per acre to 10 tons per acre, per year. The national average is 3.4 tons per acre, per year. Allowable annual soil losses in the United States range from 2 to 5 tons per acre (USDA, 1978a). The wind, sheet, and rill erosion problem has been described at four levels--none to slight (less than 2 tons per acre, per year), moderate (2 to 2.9 tons per acre), major (3 to 4.9 tons per acre), and severe (5 or more tons per acre).

The range states having severe sheet and rill erosion problems are Arkansas, Arizona, California, and Colorado. One other state, Mississippi, and the Caribbean area also have severe sheet and rill erosion problems. One with a major sheet and rill erosion problem is Texas. Range states with moderate sheet and rill erosion are Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Eleven of the range states have only a slight sheet and rill erosion problem (figure 3C-8).

Wind erosion data were compiled for the Great Plains States. New Mexico is the only state with a severe wind erosion problem and Texas is the only state with a moderate problem. In the rest of the Great Plains States the problem is only slight (figure 3C-9). This does not indicate that wind erosion occurs only on the Great Plains. Five other states--Arizona, California, Nevada, Utah, and Washington--have recognized wind erosion problems, but there are no data for these states (figure 3C-9).

Figure 3C-10 indicates the severity of wind, sheet, and rill erosion. Six range states, Mississippi, and the Caribbean have a severe erosion problem as a result of wind, sheet, and rill erosion. The range states are California, Arizona, New Mexico, Colorado, Texas, and Arkansas. Wyoming and Kansas have a major erosion problem and Nebraska, Oklahoma, and Utah a moderate wind, sheet, and rill erosion problem. The erosion problem is none to slight in 11 states.

Brush.--In this appraisal, brush is defined as woody half shrubs, shrubs, and trees that invade land on which they are not part of the potential natural (climax) plant community or occur in amounts significantly in excess of that which is natural to the site. Species listed as brush often have desirable qualities. Nevertheless, they are listed as brush because of their tendency to create resource management problems by interfering with intended land use and management.

o Status.--SCS conducted national brush inventories in 1963 and 1973 (Bredemeir, 1973). The 1973 inventory showed 277 million acres of brush on nonfederal range, native pasture, pastureland, and some lands used for recreation.

A major brush problem exists where brush is so dense that it dominates the plant community, seriously suppresses the growth of more useful plants, severely restricts land use, and leaves the soil vulnerable to erosion. Figure 3C-11 shows the general distribution and density of brush throughout the United States and Puerto Rico. Twenty major brush areas are shown. These areas contain 223 different kinds of brush (105 genera, 198 species, 3 varieties, and 2 subgenera).

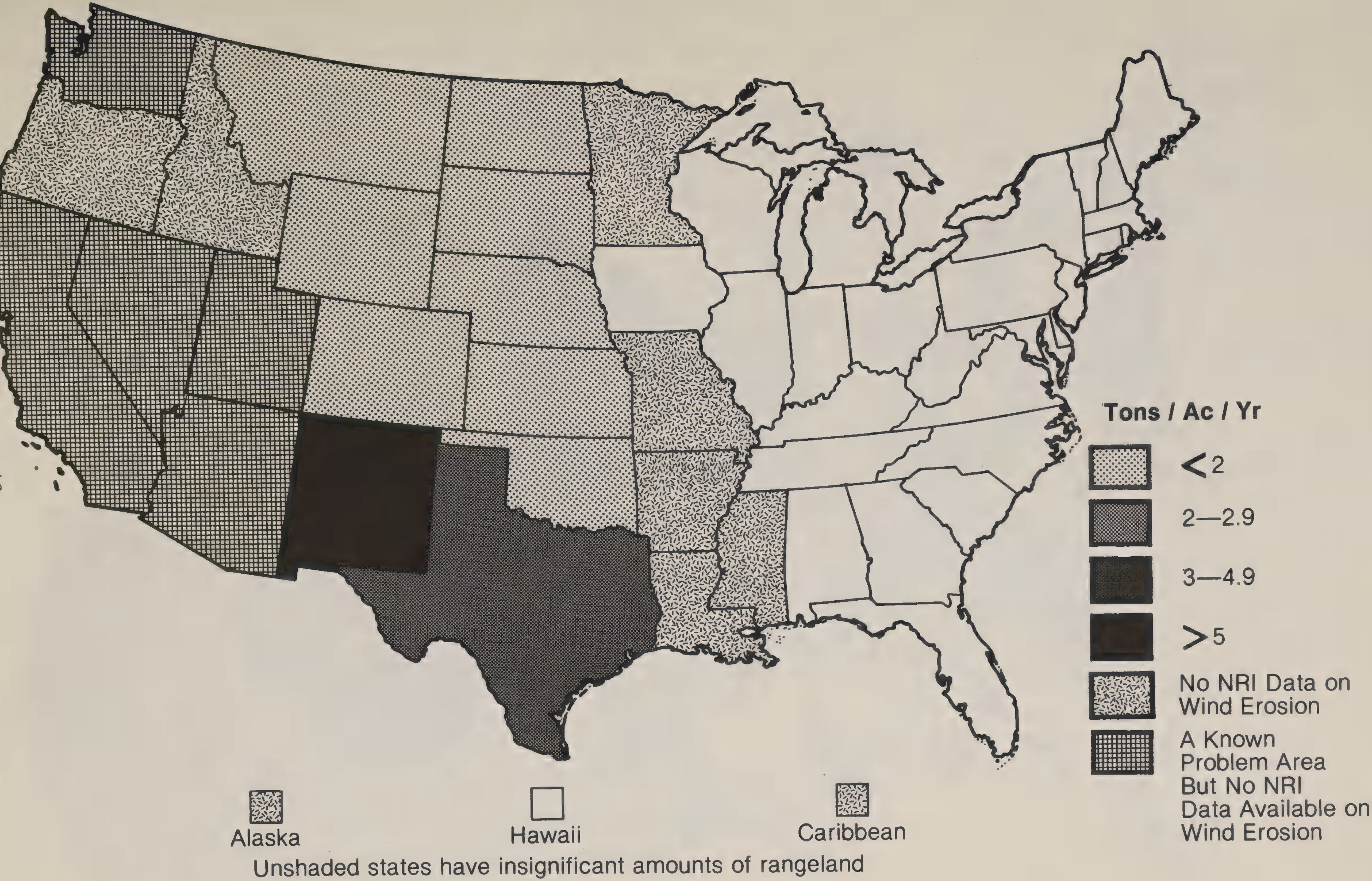


Figure 3C-9.--Wind erosion on nonfederal rangeland. (1977 National Resource Inventories)

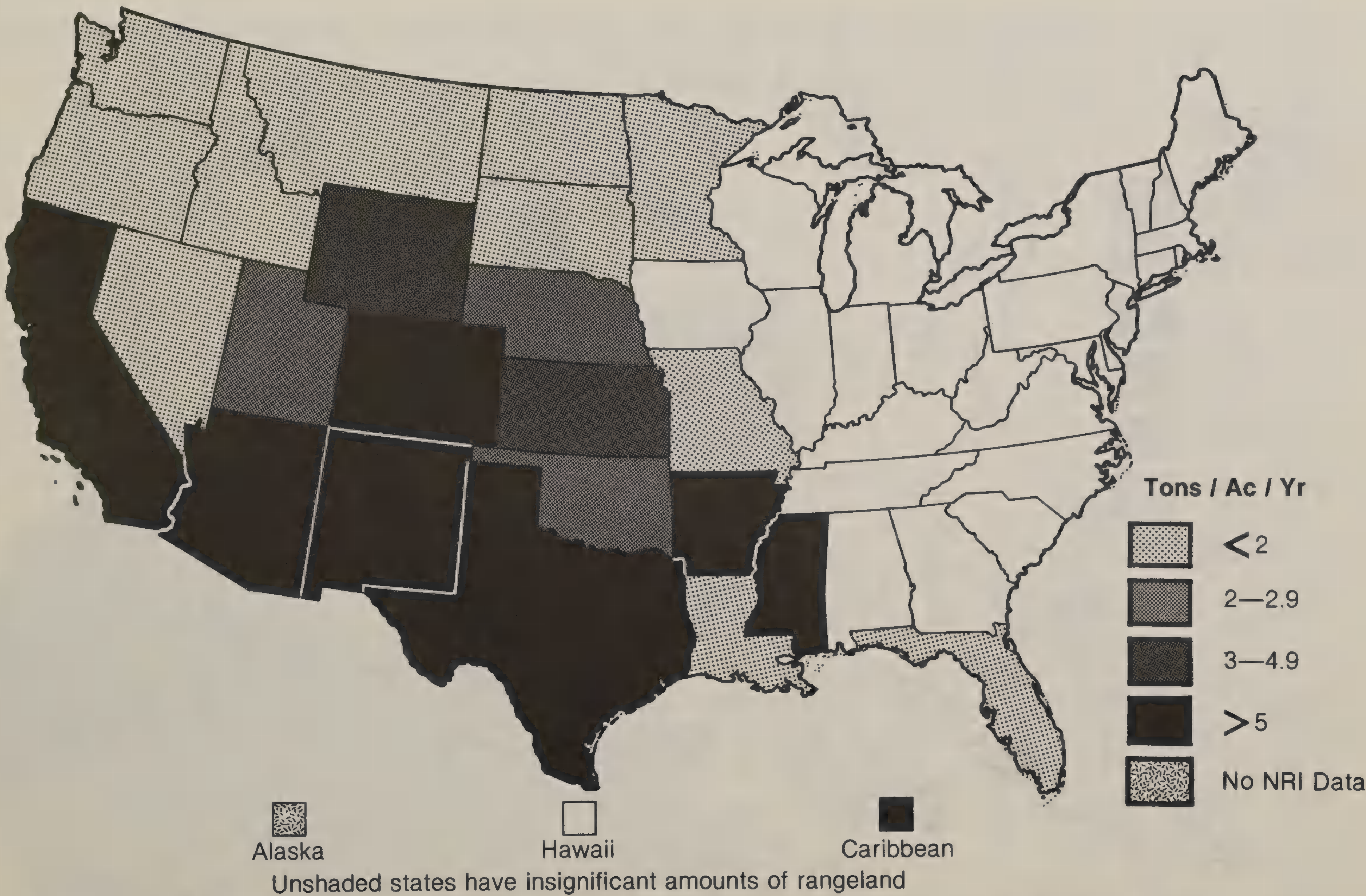


Figure 3C-10.--Total wind, sheet, and rill erosion on nonfederal rangeland. (1977 National Resource Inventories)

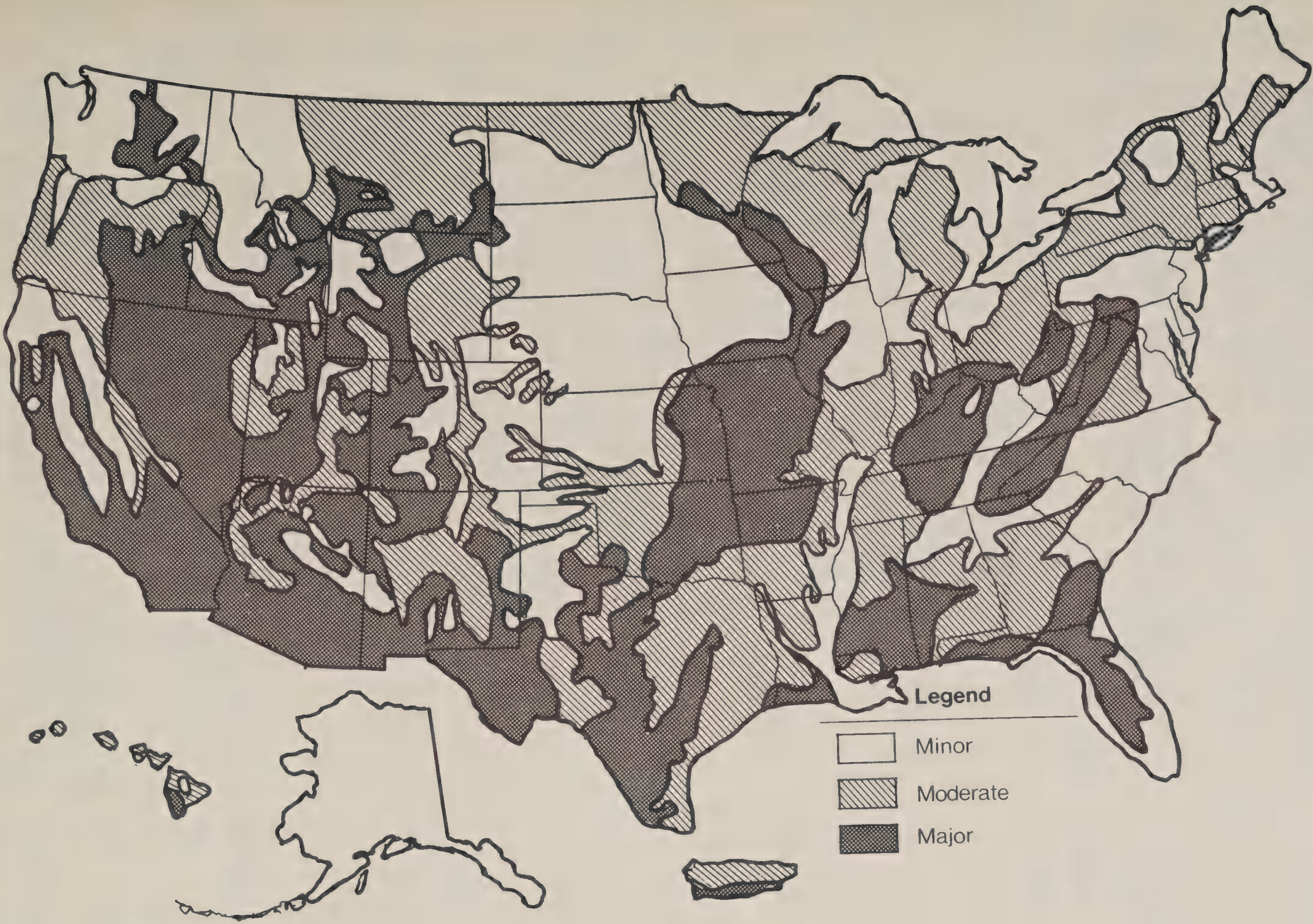


Figure 3C-11.--Brush distribution and density.

Table 3C-3 shows acres and densities of brush by states for 1963 and 1973. Table 3C-4 gives additional data on brush. It shows acres of brush by states; the percentage of brush that occurs in medium and dense stands; the number of acres of rangeland, native pasture, and improved pastureland; and the percentage of these grazing lands that are covered by brush.

o Condition.--Figure 3C-12 shows the four levels of the brush problem. The criteria used to rate the severity of the problem in each state include the percentage of grazing land covered by brush, the total acres of brush, and the percentage of brush in medium and dense stands. They are as follows:

Problem level:	Criteria:
None to slight	a/ less than 26 percent of the grazing land is occupied by brush.
	b/ less than 1 million acres are in brush.
	c/ less than 30 percent of the brush is in medium and dense stands.
Moderate	a/ 26 to 49 percent of the grazing lands is occupied by brush.
	b/ 1 to 5 million acres are in brush.
	c/ 30 to 49 percent of the brush is in medium and dense stands.
Major	a/ 50 to 75 percent of the grazing land is occupied by brush.
	b/ 5 to 10 million acres are in brush.
	c/ 50 to 75 percent of the brush is in medium and dense stands.
Severe	a/ More than 75 percent of the grazing land is occupied by brush.
	b/ More than 10 million acres are in brush.
	c/ More than 75 percent of the brush is in medium and dense stands.

For each state SCS determined the percentage of grazing land covered by brush, the total acreage in brush, and the percentage of brush in medium and dense stands. If a state met two or more of these criteria at a certain problem level, it was rated overall at that level. If a state met all three criteria at different problem levels, it was rated as having an overall problem equivalent to the middle value. According to these criteria, five states have severe brush problems--four range states and one eastern state. They are Florida, Oklahoma, Massachusetts, Wyoming, and Texas. Fourteen states have a major problem--Arizona, Arkansas, California, Colorado, Georgia, Idaho, Louisiana, Montana, New Mexico, Oregon, Utah, Washington, Nevada, and North Dakota. Seven states have a moderate brush problem--Alabama, Alaska, Hawaii, Kansas, Maine, Michigan, and Wisconsin. Twenty-four states and the Caribbean have only a slight brush problem. These ratings are on a state basis and do not recognize the severity of brush problems at specific locations.

o Trend.--SCS estimates that in 1973 brush occupied approximately 277.5 million acres of nonfederal land in the United States and the Caribbean area (table 3C-3). Compared to 1963, this acreage represents a decrease of approximately 1.2 million acres, or 0.44 percent. Although this decrease is not significant, during this 10-year period there was an important shift from dense to sparse stands.

Table 3C-3.--Acreage of brush on nonfederal land in each state in 1963 and 1973. (Total acreage with a breakdown by stand density)

States	Total acres		Sparse		Medium		Dense	
	1963	1973	1963	1973	1963	1973	1963	1973
Alabama	1,650,000	1,500,000	625,000	650,000	900,000	750,000	125,000	100,000
Alaska	500,000	520,000	300,000	320,000	200,000	200,000	-	-
Arizona	17,000,000	18,239,450	7,990,000	9,053,300	4,080,000	4,100,000	4,930,000	5,086,150
Arkansas	4,728,460	4,348,900	605,500	702,230	1,311,180	1,101,180	2,811,780	2,545,490
California	11,300,000	11,210,000	4,900,000	4,900,000	1,930,000	1,900,000	4,470,000	4,410,000
Colorado	8,500,000	7,927,000	1,275,000	2,378,100	1,700,000	3,170,800	5,525,000	2,378,100
Connecticut	18,000	12,000	5,400	6,000	5,400	4,200	7,200	1,800
Delaware	535	550	-	-	270	275	265	275
Florida	13,600,000	11,700,000	1,600,000	1,100,000	7,000,000	5,600,000	5,000,000	5,000,000
Georgia	2,000,000	2,000,000	500,000	500,000	1,450,000	1,450,000	50,000	50,000
Hawaii	1,600,000	1,600,000	800,000	850,000	700,000	660,000	100,000	90,000
Idaho	4,946,800	4,984,800	1,236,700	1,246,200	1,236,700	1,246,200	2,473,400	2,492,400
Illinois	730,000	700,000	73,000	35,000	438,000	350,000	219,000	315,000
Indiana	135,000	123,600	37,700	33,700	65,300	59,800	32,000	30,100
Iowa	540,000	546,000	100,000	104,000	390,000	390,000	50,000	52,000
Kansas	3,600,000	4,100,000	1,440,000	1,435,000	900,000	1,025,000	1,260,000	1,640,000
Kentucky	859,790	879,550	214,950	219,890	429,890	439,770	214,950	219,890
Louisiana	4,500,000	5,408,000	1,800,000	1,622,400	2,250,000	2,704,000	450,000	1,081,600
Maine	70,000	80,000	17,500	20,000	35,000	40,000	17,500	20,000
Maryland	1,800	2,000	500	500	550	650	750	850
Massachusetts	141,100	180,400	36,700	36,100	72,000	120,900	32,400	23,400
Michigan	282,140	314,600	19,750	37,750	251,105	267,410	11,285	9,440
Minnesota	595,000	523,200	119,000	156,960	297,500	235,440	178,500	130,800
Mississippi	720,000	575,000	554,400	437,000	136,800	115,000	28,800	23,000
Missouri	996,750	914,450	249,190	228,610	498,370	457,230	249,190	228,610
Montana	15,100,000	15,000,000	6,795,000	6,750,000	3,775,000	3,750,000	4,530,000	4,500,000
Nebraska	375,000	300,000	75,000	65,000	185,000	160,000	115,000	75,000
Nevada	5,615,000	5,380,000	4,800,000	4,790,000	575,000	400,000	240,000	190,000

Table 3C-3.--Acreage of brush on nonfederal land in each state in 1963 and 1973. (Total acreage with a breakdown by stand density) (continued)

States	Total acres		Sparse		Medium		Dense	
	1963	1973	1963	1973	1963	1973	1963	1973
New Hampshire	5,600	6,000	300	-	900	1,000	4,400	5,000
New Jersey	700	750	150	150	400	450	150	150
New Mexico	23,000,000	23,815,000	13,800,000	11,907,500	5,750,000	7,144,500	3,450,000	4,763,000
New York	450,000	550,000	225,000	165,000	90,000	192,500	135,000	192,500
North Carolina	87,500	93,000	59,500	60,450	24,500	27,900	3,500	4,650
North Dakota	7,000,000	7,000,000	5,785,000	5,760,000	785,000	790,000	430,000	450,000
Ohio	470,000	596,800	117,500	149,200	235,000	298,400	117,500	149,200
Oklahoma	8,925,000	11,016,000	892,500	550,800	4,462,500	3,855,600	3,570,000	6,609,600
Oregon	6,848,000	5,972,000	684,800	1,194,400	5,136,000	3,881,800	1,027,200	895,800
Pennsylvania	209,000	420,000	146,000	294,000	52,000	105,000	11,000	21,000
Puerto Rico	81,000	82,000	40,500	36,900	28,350	24,600	12,150	20,500
Rhode Island	12,500	1,600	6,500	500	3,500	750	2,500	350
South Carolina	28,000	35,000	8,400	10,500	16,800	22,750	2,800	1,750
South Dakota	103,210	106,550	87,730	90,570	14,450	14,920	1,030	1,060
Tennessee	425,000	300,000	100,000	75,000	325,000	225,000	-	-
Texas	93,389,000	91,825,000	9,338,900	22,038,000	28,016,700	30,302,000	56,033,400	39,485,000
Utah	7,573,000	7,004,000	1,135,950	1,050,600	3,029,200	3,151,800	3,407,850	2,801,600
Vermont	575	575	575	575	-	-	-	-
Virginia	495,000	520,000	297,000	312,000	124,000	130,000	74,000	78,000
Washington	5,000,000	5,200,000	4,100,000	4,500,000	600,000	500,000	300,000	200,000
West Virginia	290,000	380,000	145,000	190,000	116,000	133,000	29,000	57,000
Wisconsin	750,000	830,000	60,000	66,400	630,000	655,700	60,000	107,900
Wyoming	23,500,000	22,700,000	14,570,000	14,982,000	2,350,000	2,724,000	6,580,000	4,994,000
Totals	278,748,460	277,523,775	87,771,595	101,112,285	82,603,365	84,879,525	108,373,500	91,531,965
Percentage of total			31.5	36.4	29.6	30.6	38.9	33.0
Acreage change		-1,224,685		+13,340,690		+2,276,160		-16,841,535
Percentage change		-0.44		+15.2		+2.8		-15.5

Table 3C-4.--Brush, brush densities, brush on grazing lands

State	1973 Acres of brush	Percentage in medium and dense stands	Acres of rangeland, native pasture-land, and pastureland	Percentage of grazing lands covered by brush
Alabama-------------	1,500,000	57	4,120,000	36
Alaska--------------	520,000	39	6,275,000	1
Arizona-------------	18,239,450	50	35,103,000	52
Arkansas------------	4,348,900	84	5,874,000	74
California----------	11,210,000	56	18,688,000	60
Colorado------------	7,927,000	70	25,403,000	31
Connecticut---------	12,000	50	113,000	11
Delaware------------	550	100	22,000	2.5
Florida-------------	11,700,000	91	8,498,000	138*
Georgia-------------	2,000,000	75	3,232,000	62
Hawaii--------------	1,600,000	47	990,000	162*
Idaho---------------	4,984,800	75	7,700,000	65
Illinois------------	700,000	95	3,068,000	23
Indiana-------------	123,600	73	2,148,000	6
Iowa----------------	546,000	81	4,527,000	12
Kansas--------------	4,100,000	65	18,975,000	22
Kentucky------------	879,550	75	5,734,000	15
Louisiana-----------	5,408,000	70	3,271,000	165*
Maine---------------	80,000	75	249,000	32
Maryland------------	2,000	75	480,000	.4
Massachusetts-------	180,400	80	92,000	196*
Michigan------------	314,600	88	1,226,000	26
Minnesota-----------	523,200	70	2,999,000	17
Mississippi---------	575,000	24	4,070,000	14
Missouri------------	914,450	75	12,858,000	7
Montana-------------	15,000,000	55	41,484,000	36
Nebraska------------	300,000	78	24,896,000	1
Nevada--------------	5,380,000	11	7,648,000	70
New Hampshire-------	6,000	100	93,000	5
New Jersey----------	750	80	145,000	.005
New Mexico----------	23,815,000	50	42,481,000	56
New York------------	550,000	70	2,282,000	24
North Carolina------	93,000	35	2,025,000	4
North Dakota--------	7,000,000	18	12,113,000	58
Ohio----------------	596,800	75	2,614,000	23
Oklahoma------------	11,016,000	95	23,285,000	47
Oregon--------------	5,972,000	80	11,875,000	50
Pennsylvania--------	420,000	30	1,797,000	23
Puerto Rico---------	82,000	55	927,000	9
Rhode Island--------	1,600	70	15,000	11
South Carolina------	35,000	70	1,242,000	3

Table 3C-4.--Brush, brush densities, brush on grazing lands--Continued

State	1973 Acres of brush	Percentage in medium and dense stands	Acres of rangeland, native pasture-land, and pastureland	Percentage of grazing lands covered by brush
South Dakota--------	106,550	15	24,611,000	4
Tennessee-----------	300,000	75	5,473,000	5
Texas---------------	91,825,000	76	114,174,000	80
Utah----------------	7,004,000	85	9,989,000	70
Vermont-------------	575	0	540,000	.002
Virginia------------	520,000	40	3,276,000	16
Washington----------	5,200,000	14	7,292,000	71
West Virginia-------	380,000	50	2,039,000	19
Wisconsin-----------	830,000	92	2,746,000	30
Wyoming-------------	22,700,000	34	26,904,000	84

* Percentages are greater than 100 because brush acreages may include brush on grazable woodlands.

Source: Brush Inventory for Nonfederal Land in the USA (Bredemeir, 1973)
1977 National Resources Inventories (USDA, 1978a).

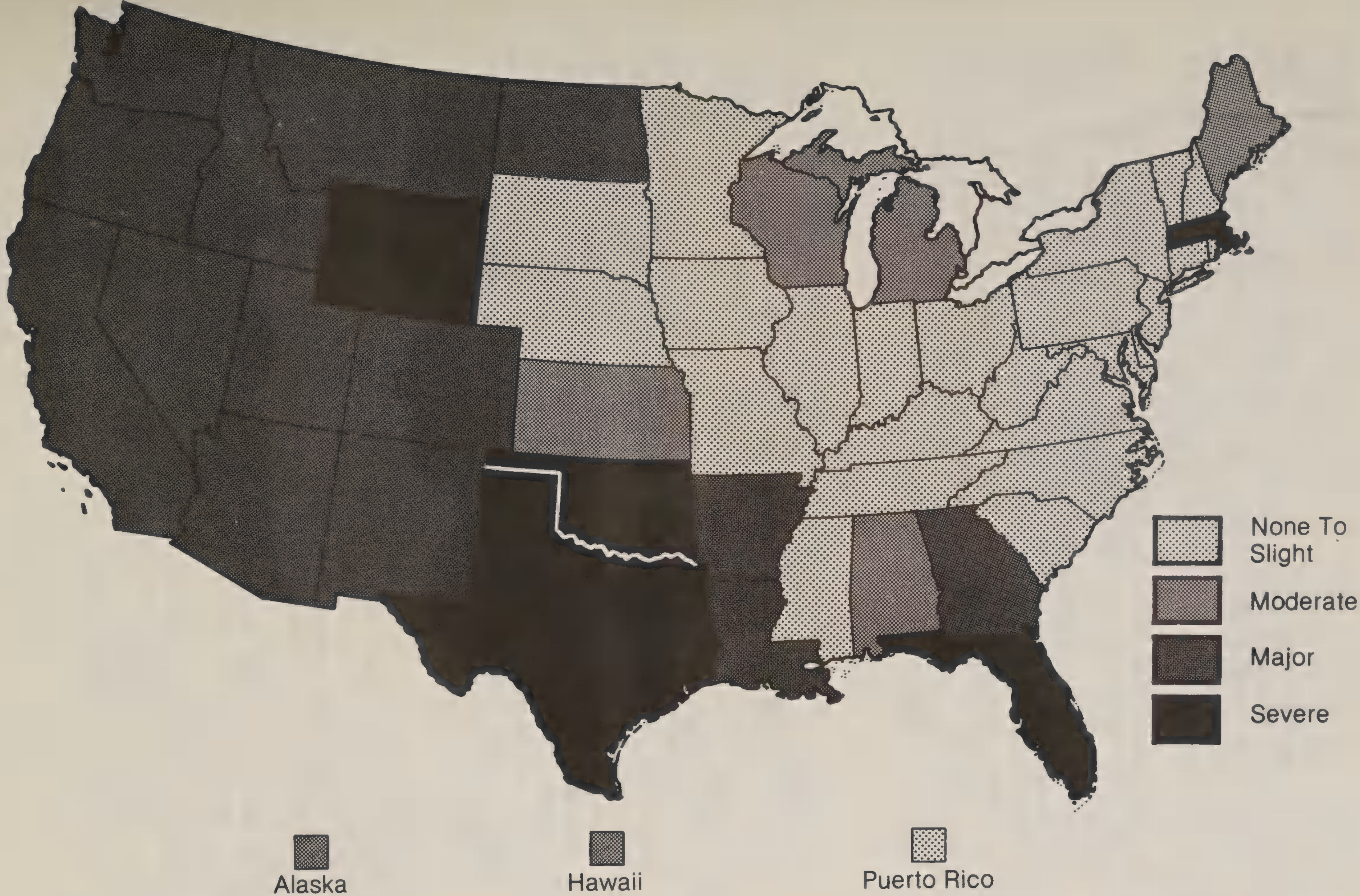


Figure 3C-12.--The brush problem on nonfederal rangeland, native pasture, and pastureland. (1973 SCS Brush Inventory for Nonfederal Lands)

Sparse, medium, and dense stands were approximately 31, 30, and 39 percent respectively of the total (table 3C-3) in 1963. By 1973, the percentages had changed to approximately 36, 31, and 33 percent, respectively. The sparse stand had increased by approximately 13.3 million acres, an increase of about 15 percent over 1963. The medium stand had increased by approximately 2.3 million acres, or 3 percent. The dense stand had decreased nearly 16.8 million acres, a reduction of about 15.5 percent since 1963.

Trends for each state are shown in figure 3C-13. The acreage of brush, as of 1973, was increasing in 26 states and the Caribbean, decreasing in 20 states, and static in 4 states. The density of brush was increasing in 22 states and the Caribbean, decreasing in 24 states, and static in 4. Both acreage and density were increasing in 20 states and the Caribbean, while both were decreasing in 18 states. Two states showed no change in acreage or density. Brush management activities have been successful in reducing the overall density of the brush stand, but not in reducing the total acreage. Eradication is rarely a planned objective of brush management and it is economically, ecologically, and technically unfeasible.

Trend

Range condition was estimated by SCS state range conservationists for all states in 1963 and in 1977. A comparison of the 1963 and 1977 range condition surveys (figure 3C-4) indicates an overall upward trend. Figure 3C-5 shows trends in each state. Sixteen states have an upward trend. Idaho, Louisiana, Nevada, and Utah show little or no change in the amounts of excellent, good, fair, and poor condition range. California, Florida and Minnesota show a downward trend. Because of the Mediterranean climate and annual vegetation in much of California, ecological range condition has less significance there than elsewhere (Heady, 1956). Florida's large decline is due mainly to changes in the concept of climax vegetation. Pineland threeawn was once accepted as the climax dominant grass on Florida flatwoods range. Recent research and experience indicate, however, that pineland threeawn increases with continuous overuse, displacing creeping bluestem and chalky bluestem. Thus a substantial acreage occupied primarily by pineland threeawn was downgraded in range condition between 1963 and 1977 (Pendleton and Schmude, 1979).

Rangeland Base.--The 1975 Potential Cropland Study (USDA, 1977) indicates that from 1967 to 1975 just over 4 million acres of rangeland and pastureland were converted to urban, built-up, and water areas (figure 3C-3) (USDA, 1977). This represents about 1/2 million acres per year. Nationally such conversions have had little effect on range use, management, or production, but locally they may have had very significant effects. A net gain of 20 million acres in range occurred from cropland converted to grassland. There was also a gain of 48 million acres in rangeland and pastureland from forest land. The bulk of this was mainly due to reclassification of some vegetative types from noncommercial forest to rangeland. Future losses in the rangeland base will occur chiefly through conversion to urban buildup and cropland. The RPA Assessment projects a 57 million acre loss by the year 2030.

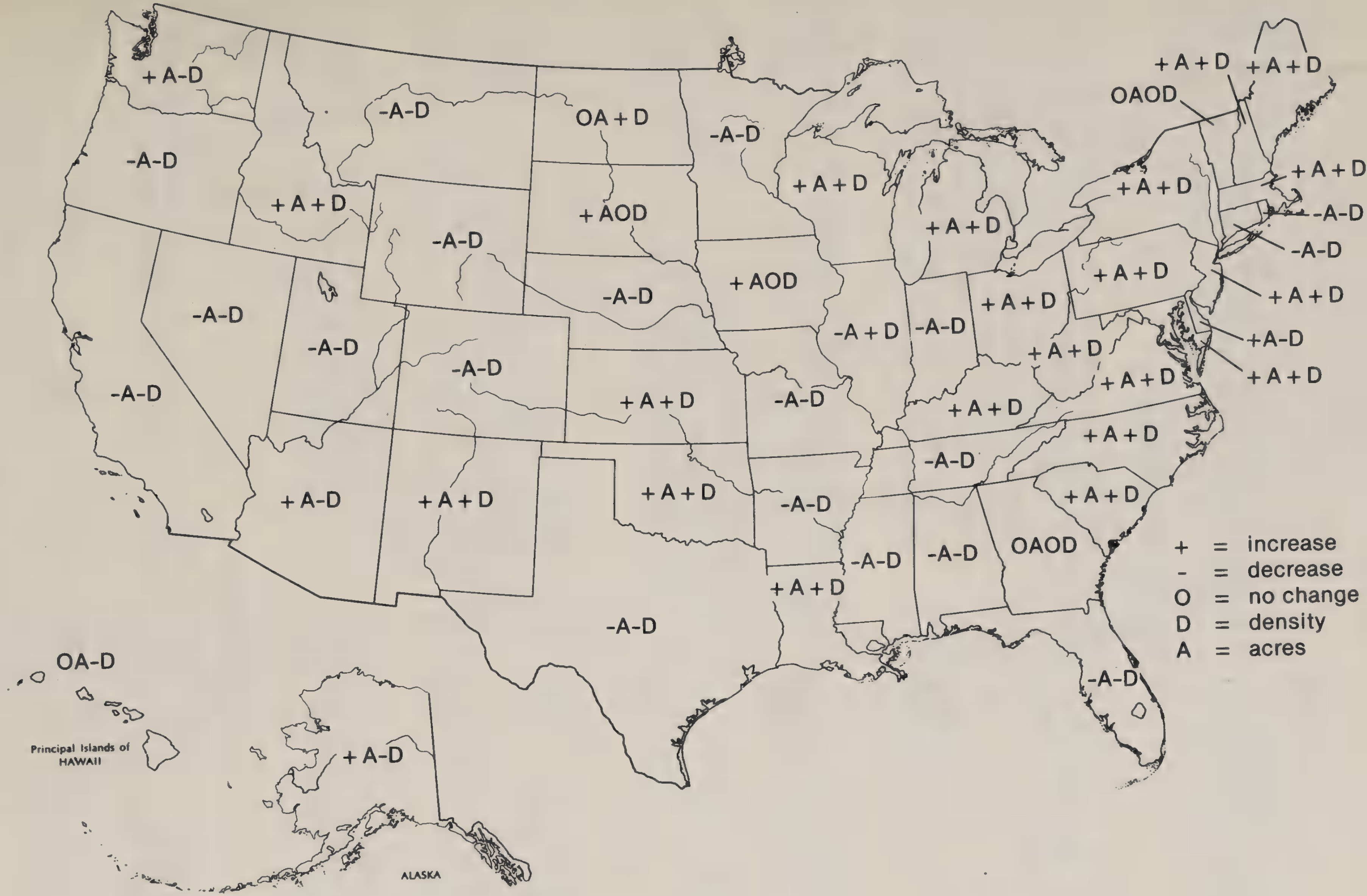


Figure 3C-13.--Trend in density and acres of brush on nonfederal rangeland, native pasture, and pastureland. (1973 SCS Brush Inventory for Nonfederal Lands)

Native Pasture

Status

There are approximately 17.2 million acres of land used as native pasture in the conterminous United States (figure 3C-14). Hawaii, Puerto Rico, and the Virgin Islands have 524,000 acres. Ten of the conterminous states reported no native pasture. There are no data on this resource for Alaska.

Condition and Trend

The vegetation used for native pasture consists of subclimax plant communities managed for grazing on potential forest land. It consists of grasses, forbs, grass-like plants, and some shrubs. Since brush is a natural component of forest, it frequently becomes a problem on land used as native pasture. The brush inventory data used in this study were combined for rangeland, native pasture, and pastureland. For extent and severity of the brush problem on native pasture, see table 3C-4 and figure 3C-12. There is no system for defining or recognizing trends on native pasture.

Soil Problems.--Most of the soils used for native pasture are in land capability classes IV through VIII. These soils are easily eroded if they lack a protective cover. Erosion, therefore, is the major soil problem.

Sheet and rill erosion is considered a problem when it exceeds 2 tons per acre (USDA, 1978a). The problem has been described at 4 levels of soil loss. They are: none to slight--less than 2 tons per acre, per year; moderate--2 to 2.9 tons; major--3 to 4.9 tons; and severe--5 tons or more (figure 3C-15).

On 60 percent of the native pasture soil loss through sheet and rill erosion excedes 2 tons per acre. Loss in excess of 2 tons per acre occurs on IIIe, IVe, IVs, VIe, VIs, VII, and VIII soils (table 3C-2). The rate of loss ranges from 2.43 tons per acre, per year for class IIIe soils to 12.57 tons per acre, per year for classes VII and VIII. Ninety-three percent of all soil lost through sheet and rill erosion on native pasture is lost from these soils.

Wind erosion on native pasture was reported in three states. Colorado reported a loss of 0.6 ton per acre annually, Kansas less than 0.1 ton, and New Mexico showed 3.34 tons. All wind erosion occurred on soils in capability classes VII and VIII.

Alaskan Range Resources and Tundra

Alaska's rangeland spans 231,471,600 acres through the state's six planning regions (USDA, 1979). It includes moist tundra, wet tundra, alpine tundra, high brush, and low brush-muskeg bog ecosystems.

About 10 to 13 million acres of grassland types are suitable for cattle, sheep, and horses (Tomlin, 1957; Snodgrass, 1974). Nine million acres are suitable for sheep grazing; 6.8 million acres are suitable for cattle; 3.4 million acres are suitable for horses (table 3C-5).

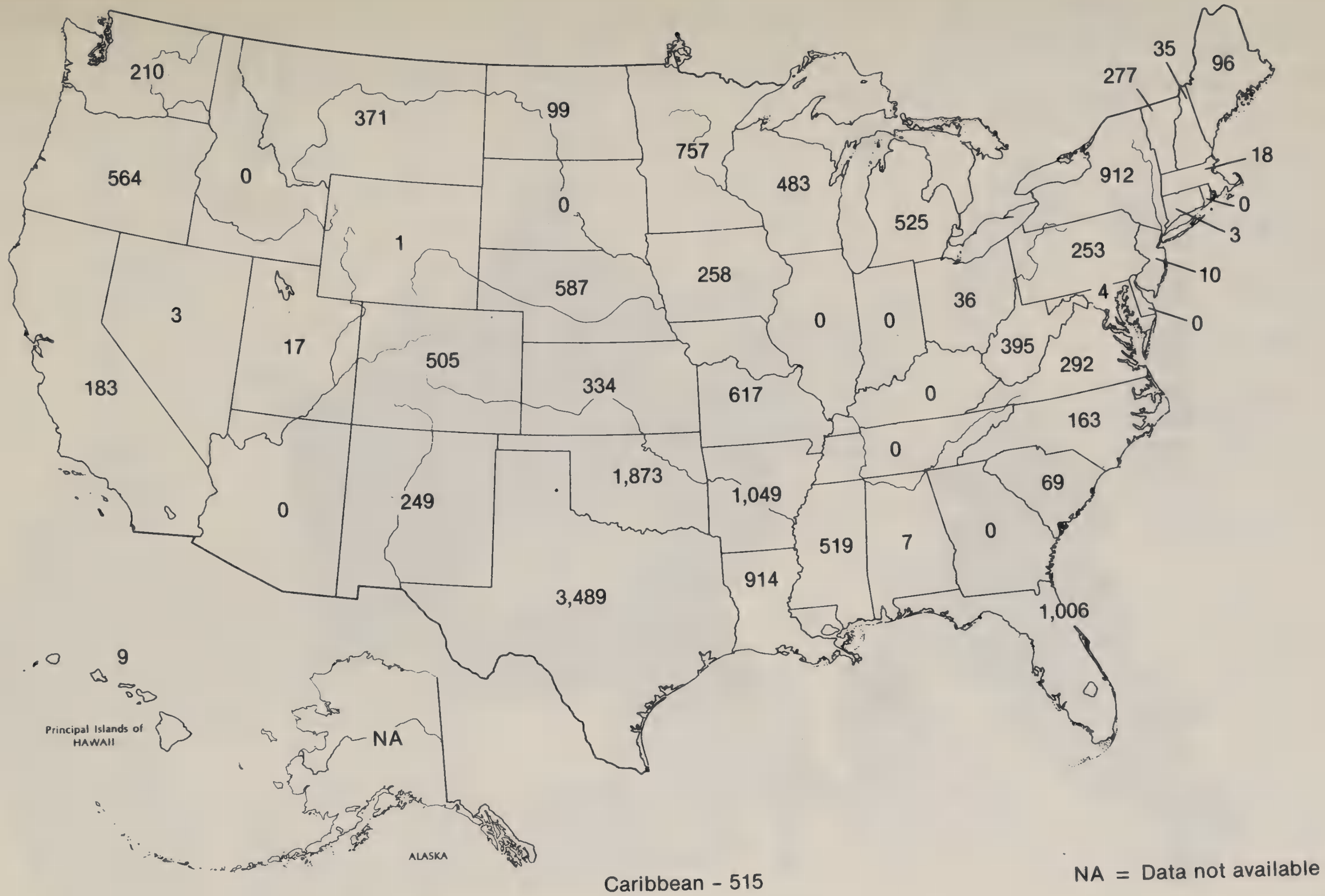


Figure 3C-14.--Acres in native pasture (1,000 acres). (1977 National Resource Inventories)

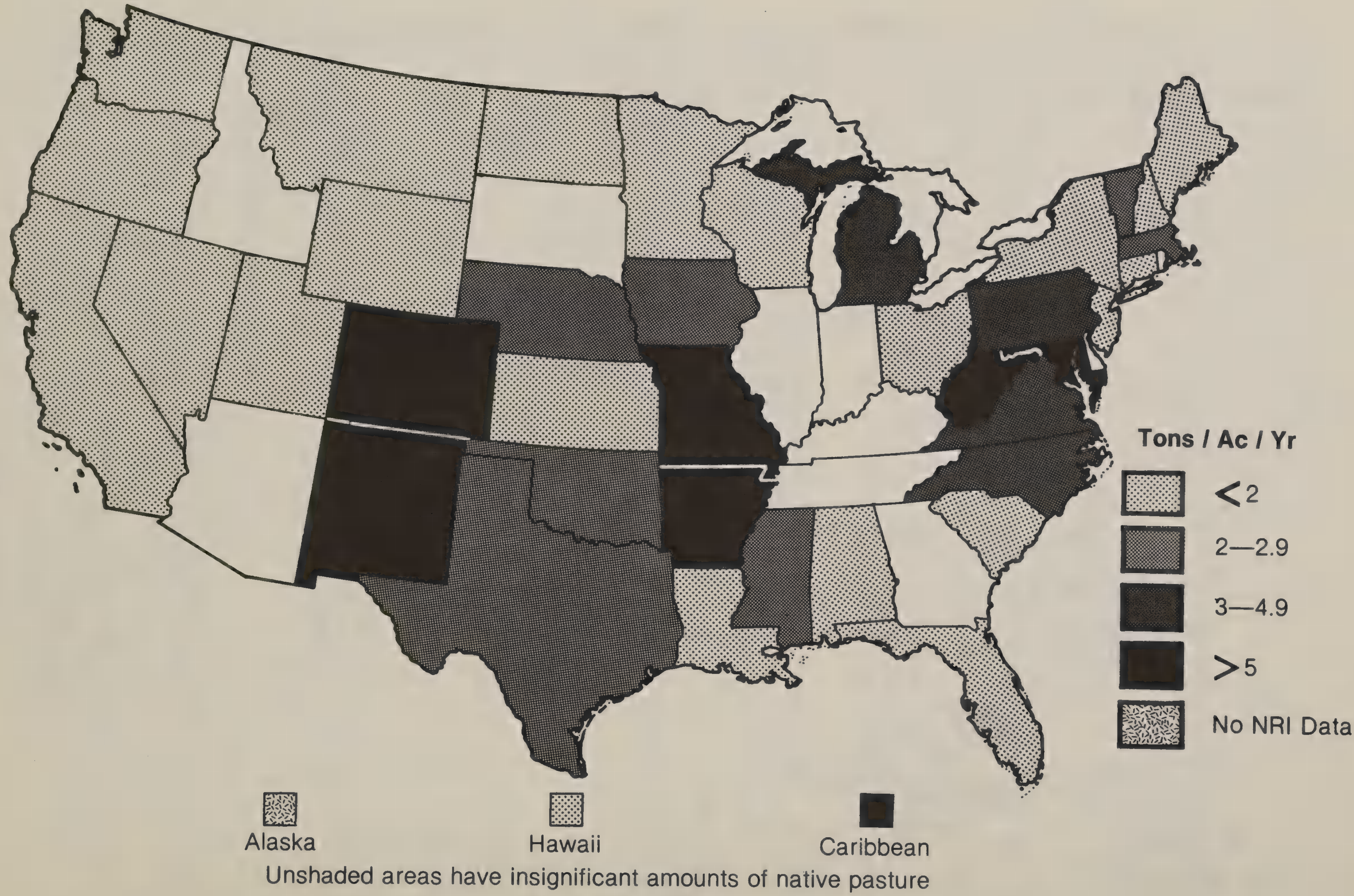


Figure 3C-15.--Sheet and rill erosion on native pastureland. (1977 National Resource Inventories)

Table 3C-5.--Estimated range potential in Alaska (acres)

Location	Sheep	Cattle	Horses
Aleutian Islands-------	2,330,000	-------	-------
Shumogin group---------	372,000	372,000	-------
Kodiak Island----------	2,208,184	2,208,184	-------
adjacent islands-----	321,200	321,200	-------
Southeast Alaska-------	-------	60,400	-------
Kenai Peninsula--------	480,000	480,000	-------
Matanuska-Susitna------	242,000	242,000	242,000
Copper River drainage--	200,000	200,000	200,000
Fairbanks area---------	2,957,000	2,957,000	2,957,000
Total-------------	9,110,384	6,840,784	3,399,000

Source: Grazing lands of Alaska (Tomlin, 1957).

Analysis of data from the preliminary RPA assessment indicates the major use and potential expanded use of native or introduced species by grazing animals in the 11 ecosystems (table 3C-6).

Cattle grazing could be expanded on the coastal hemlock-Sitka-spruce, the upland spruce hardwood, and the Aleutian moist tundra. Sheep grazing could be expanded on the Aleutian moist tundra. Reindeer could graze in six ecosystems they do not graze now and their grazing on the moist tundra could be increased. Expansion of the reindeer industry would result in competition with the caribou in most places. One other grazer that receives increasing attention for wool and meat production in Alaska is the musk ox. It grazes the moist and wet tundra types. It could also graze the high brush and the Aleutian alpine tundra.

The better grasslands of the state, those more suitable for domestic livestock grazing, extend from the eastern Aleutian Islands across Kodiak and along the Kenai Peninsula to Ninilchik and the Fox River Valley, including the Caribou Hills.

Domestic livestock (cattle, sheep, horses) were introduced as early as the 1700's. Commercially, cattle were introduced in 1875, sheep in 1918, and reindeer in 1892. The expansion of range enterprises using domestic livestock is limited to grassland types and is progressing at a slow rate. The tundra has the greater potential for meat production because of its vast acreage and the availability of animals specifically adapted to it. Reindeer, caribou, and musk oxen are physiologically adapted to using tundra forage more efficiently than are cattle or sheep. They also can reduce their metabolism during the harsh winter and, therefore, need less feed. Cattle and sheep, on the other hand, have increased energy needs in winter.

Table 3C-6.--Plant communities of Alaska and their use or potential use by grazing animals

Resource unit	Cattle	Sheep	Caribou	Moose	Muskeg	Deer	Mountain goats	Elk	Bison	Dall Mountain sheep	Reindeer
Coastal hemlock - Sitka-spruce-----	S,E			S		M	S	S			
Bottomland spruce-poplar-----------	P	P		M					S		
Upland spruce hardwood---------	S,E		S	M					S,E,S		P
Low land spruce hardwood---------			M	M					S		M
Aleutian moist tundra-----------	S,M,E	S,M,E	S,M,E								P
High brush---------	P,S			P,S							P,L
Moist tundra-------	S	S	M,E	P,E	S,E			L			M,E
Wet tundra---------			M	L	S,E						M
Aleutian alpine tundra-----------	P,E	S,M	S,M,E	P	P	P		P	P		P
Alpine tundra------	P	P	S,L,E	S,L		S,L,E	S,L	S,L,E		S,L	P
Low brush muskeg-bog-------			M	M							P

M = major user P = potential user L = limited user

S = limited to selected areas, fringe areas E = potential for expanding current use

Red meat production from reindeer on tundra ranges from .023 pounds per acre near Buckland and .067 pounds per acre on the Seward Peninsula to .125 pounds per acre in the lower Yukon and up to .37 pounds per acre on Hagemeister Island. Although the total per acre production is low, the 180 million acres of tundra represent a significant resource for producing red meat.

Tundra is classified as three types (Joint Federal-State Land Use Planning Commisssion for Alaska, 1973)--moist tundra, wet tundra, and alpine tundra. Moist tundra ecosystems usually form a complete ground cover and are extremely productive during the growing season. Production has been recorded at near zero on rocky barren sites, at 900 pounds per acre on grass-sedge meadows, and up to 4,500 pounds per acre on exceptional wet sites.

Wet tundra occurs in areas of little topographical relief and is covered with pools, ponds, and shallow lakes in summer. This type consists of a dominant mat-forming vegetation of sedges, cottongrass, lichens, and mosses. Forbs and woody species are on the drier sites. Annual production ranges from 500 to 1,000 pounds per acre. One study reported an average of 775 pounds.

Alpine tundra systems occur on all the mountain ranges of Alaska and on exposed ridges in the arctic and southwestern coastal areas. Vegetation consists of low plant mats, both herbaceous and shrubby, and low growing herbs, lichens, grasses, and sedges. Annual production on this type is lower than on moist or wet tundra.

Status

Climax tundra and its seral stages cover 1,250,000 square miles of North America (Shelford, 1963). According to the Joint Federal-State Land Use Planning Commission for Alaska (1973) there are 183 million acres of tundra in the United States. The Forest Service RPA figures, however, list only 178.2 million acres. Table 3C-7 shows the distribution of tundra by types throughout the six regions of Alaska.

Table 3C-7.--Acres of tundra in Alaska 1/
(Million acres)

Tundra type	Arctic	North-west	Yukon	South-west	South-central	South-east	Subtotals by type
				(million acres)			
Moist tundra----	25.8	12.3	7.0	16.8	3.6		65.5
Wet tundra------	8.5	7.0	6.6	9.2	1.0	.3	32.6
Alpine tundra---	7.0	9.7	21.1	18.7	20.9	7.5	84.9
Total------	41.3	29.0	34.7	44.7	25.5	7.8	183.0

1/ Joint Federal-State Land Use Planning Commission for Alaska, 1973.

The Forest Service RPA Assessment classifies tundra into five categories instead of the three used by the Alaska Land Use Planning Committee. Table 3C-8 gives the RPA data showing tundra type.

Table 3C-8.--Tundra type

Type	(1,000 acres) 1/
Moist tundra----------------------	62,521
Aleutian moist tundra------------	2,176
Wet tundra-----------------------	29,754
Alpine tundra--------------------	79,764
Aleutian alpine tundra-----------	4,000
Total----------------------	178,215

1/ Forest Service.

Indian and Eskimo grazing enterprises on tribal, state, and federally owned rangelands cover about 2 to 3 percent of all tundra lands. These lands are used mostly for grazing by reindeer. Grazing by cattle, sheep, and horses is limited to the moderate climate areas of grasslands and grassy type tundra. These areas are located in the Aleutian Islands, on the Seward Peninsula, the southeast region, the Kenai Peninsula, the Matanuska-Susitna area, and the Copper River drainage (Tomlin, 1957). See table 3C-5. Snodgrass (1974) reported a larger acreage than Tomlin. He cited 12.5 million acres in the northwest, southwest, and south-central regions as suitable for cattle, sheep, goats, and horses.

Condition and Trend

The technology needed to evaluate the range condition of tundra is only now being developed. Range surveys made in the past have been general and judgmental and lacked data collection. SCS is surveying Alaskan range using remote sensing from space satellites, aerial photography and ground verification (George et al., 1977). Thus far only 4 million acres in the Seward Peninsula, Kotezebue area and Nevada region have been inventoried. SCS will survey another 4 million acres in 1979. SCS range inventories on 22 million acres of the Seward Peninsula will be completed by 1983. Therefore, the RCA Appraisal will rely mostly on historical records and on the RPA Assessment.

In the past, Alaskan rangeland has deteriorated mainly in areas where domestic livestock and reindeer have been introduced. The rangeland cattle and sheep industry has failed to develop significantly. Because of the unique adaptability of reindeer to tundra and the enthusiasm of a few capable entrepreneurs, reindeer became a large scale industry during the 1920's and early 30's. The number of reindeer increased from 2,692 in 1900 to over 600,000 in 1932. The Congressional Record (March 8, 1979) contains a discussion of the rangeland problems that developed concurrently with the

increase in reindeer. "At that same time government surveys found evidence of serious overgrazing. Lichen pastures required from 15 to 30 years to recover from heavy use."

The reindeer industry failed because of overstocking, range failure, political pressure from American cattlemen, the Great Depression of the 30's, and the general disinterest of people from the 48 states in pioneering in Alaska. The cattle and sheep industry never developed to its full potential for the same reasons. The number of reindeer decreased to 252,550 in the next 8 years. By 1952, there were only 26,735. The tundra that had been overgrazed in the late 20's and early 30's recovered in the 40 or so years after the decline of the reindeer. There is little evidence of that type of grazing abuse on the rangeland today.

Overgrazing is not too much of a problem with the caribou since they move at will from used areas to new areas of abundance. Overgrazing by cattle and sheep is only a minor local problem because the range suited to them is far from being fully stocked.

Various authors have cited overgrazing on St. George, St. Matthew's, Nunivak, and Kodiak Islands. They do not offer data, however, on the extent and intensity of the problem (Snodgrass, 1974; Tomlin, 1957; Congressional Record, 1979). There are also references to the poor condition of range on St. George, St. Matthew's, and Nunivak Islands in the preliminary RPA studies (1977). The 1979 RPA draft report contains no acreage figures (table 3C-9).

Periodic trampling, particularly when the vegetation is dry, causes range deterioration. Reindeer and caribou cause most of this type of damage. This situation is now watched closely since grazing on public lands is receiving the attention of range scientists, who are also helping Alaskan natives to use sound range management techniques. Such management will enable the reindeer industry to expand without damaging tundra rangelands.

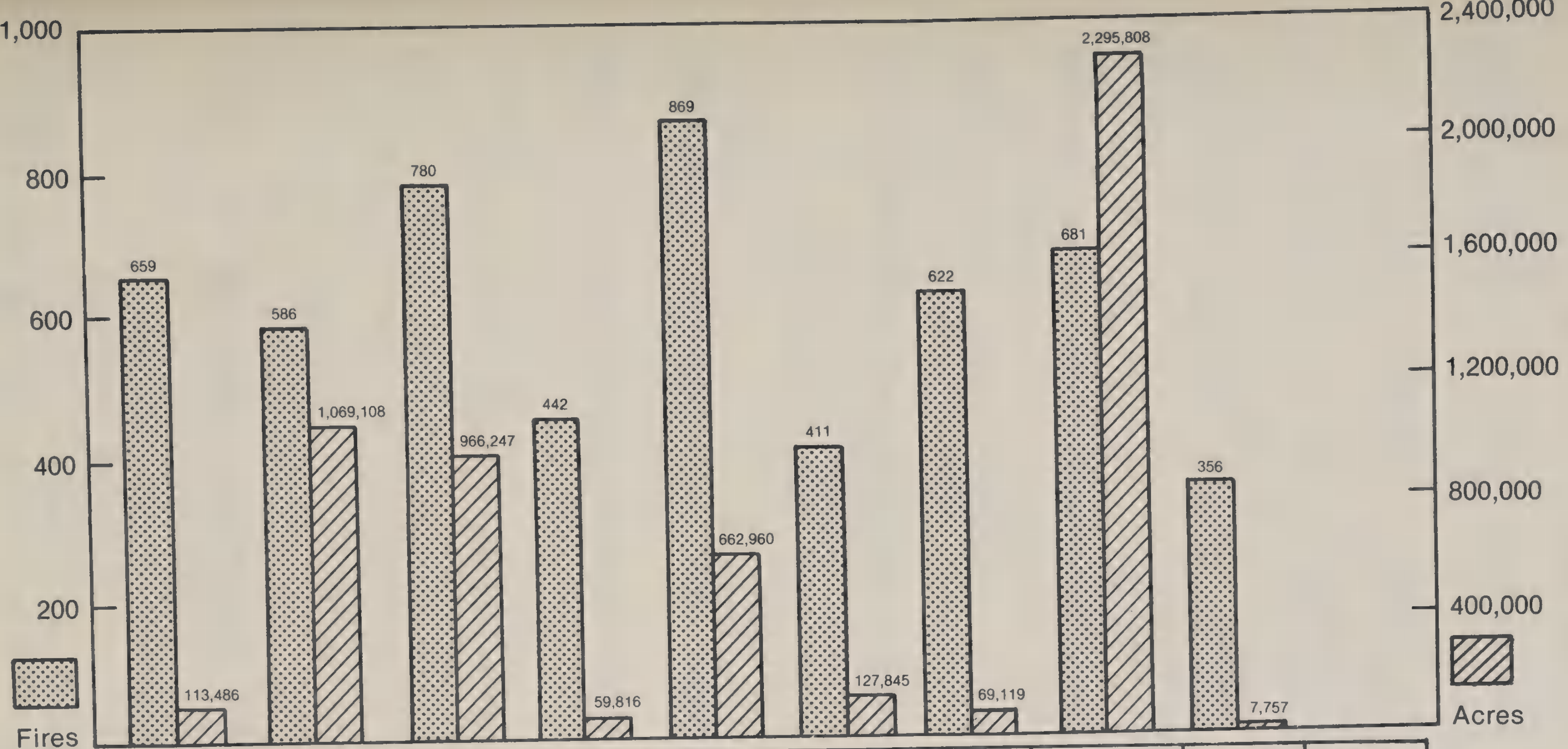
Fire is another cause of range deterioration on tundra lands. Fire is a problem in areas near mines. Lightning and other natural causes are responsible for fire on more than 90 percent of the burned land. Less than 0.001 percent (3,000 acres) of the 2.3 million acres burned in 1977 was burned by fires caused by man (figure 3C-16).

About a half million acres of tundra have burned each year for the past 10 years. Although this acreage represents serious local problems that require controlled grazing through herding and possibly fencing, the burned land amounts to only .003 percent of the total tundra area in any one year.

Problems on tundra rangeland are minimal from a national perspective. It should be noted, however, that these rangelands are fragile. They are easily damaged through mismanagement and may need from one to several decades to recover. The renewed interest in reindeer and musk oxen for meat and wool production will increase grazing pressure on the tundra. A long range program is needed to ensure the proper use and preservation of this vast resource in the face of expanding and developing industry.

Table 3C-9.--Alaska--Condition of rangeland ecosystems
(Modified version of table 5.8, 1979 RPA Range Assessment)

Ecosystem	Total	(High) Excellent		(Moderately high) Good		(Moderately low) Fair		(Low) Poor	
	1000 Acres	1000 Acres	% of ac	1000 Acres	% of ac	1000 Acres	1000 % of Ac	Acres	% of Ac
Muskeg-bog---------	14,383	14,383	100	----	----	----	----	0	0
Shrub-thickets-----	17,762	14,853	84	2023	11	886	5	0	0
Moist tundra-------	66,576	40,344	61	22,902	34	3,330	5	0	0
Wet tundra---------	26,256	26,256	100	0	0	0	0	0	0
Alpine tundra------	103,114	85,069	82	18,045	18	0	0	0	0
Aleutian moist tundra-----------	1,215	850	70	365	30	0	0	0	0
Aleutian alpine tundra-----------	2,165	1,517	70	541	25	107	5	0	0
Total--------	231,471	183,272	79	43,876	19	4,323	2	0	0



Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Lightning Caused	140	240	472	123	384	134	227	401	82	
Man Caused	347	232	173	213	398	210	345	222	242	
False Alarm	172	114	135	106	87	67	50	58	32	
Total	659	586	780	442	869	411	622	681	356	
Lightning Caused	107,108	1,059,921	963,999	50,480	645,192	86,208	54,885	2,292,431	5,809	
Man Caused	6,378	9,187	2,248	9,336	17,768	41,637	14,234	3,377	1,948	
Total	113,486	1,069,108	966,247	59,816	662,960	127,845	69,119	2,295,808	7,757	

Figure 3C-16.--Annual number of fires and acres burned on Alaska tundra lands.

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Section D-Forest Land

The nonfederal forest land provides wood, water, wildlife, herbage, and recreation. Its productive capability depends on the soil, climate, topography, and associated vegetative cover. Differences in the physical characteristics of soils, the supplies of moisture and nutrients, topography, and management all contribute to the diversity of this resource and to the varied benefits that we receive.

This section provides information affecting the soil and water conservation programs for nonfederal forest land. It considers mainly wood and herbage production. Information on related water, wildlife, and recreation uses of these lands can be found in other sections of this appraisal under their respective headings. All information on the acreage of nonfederal forest land is based on the SCS National Resource Inventories (USDA, 1978b), except for Alaska, which is based on the Forest Service publication "Forest Statistics of the U.S., 1977" (USDA, 1978a).

Nonfederal forest land is land that is mainly under private ownership, but it also includes state and municipal land. It is defined as land under at least a 25 percent tree canopy cover or land at least 10 percent stocked with forest trees of any size, including land formerly forested that will be naturally or artificially reforested. It does not include transition zones between heavily forested and nonforested land that can also be defined as rangeland, nor does it include forested areas that can be defined as urban or built-up land. As a result of these exclusions, the acreage of nonfederal forest land shown in the 1977 SCS National Resource Inventories is smaller than that shown in other inventory reports. Federal forest land areas shown in table 3D-1 cover all areas that meet this forest land definition but also include forested areas that meet rangeland or urban and built-up definitions.

Status

Area.--The area classified as forest land according to the above definition occupies 662 million acres of the 2,265 million acres of land in the Nation. There are 285 million acres of federal forest land and 377 million acres of nonfederal forest land. See table 3D-1.

States in the eastern half of the Nation contain nearly 83 percent of the nonfederal forest land and the western states contain 17 percent (figure 3D-1). The south central region in the east contributes 26 percent of the national total, the southeast region 20 percent, the northeast region 19 percent, and the north central region 18 percent. The Pacific Northwest--Alaska, Washington, and Oregon--contribute 8 percent of the national total, the Rocky Mountains 5.5 percent, and the Pacific Southwest 3 percent. The Great Plains region has very little nonfederal forest land, only one-half of 1 percent of the national total.

Vegetative Cover.--The vegetative cover on nonfederal forest land varies greatly as a result of differences in climate, topography, and soils. The forest cover types referred to in this appraisal are those defined in the Forest Survey by the Forest Service (USDA, 1967).

Table 3D-1.--Federal and nonfederal forest land in 1977, by regions, subregions, and states

	Federal 1/	Nonfederal 2/	Total
		(1,000 acres)	
North			
Northeast			
Connecticut----------------	2	1,418	1,420
Delaware-------------------	5	360	365
Maine----------------------	228	16,520	16,748
Maryland-------------------	155	2,160	2,315
Massachusetts--------------	60	2,756	2,816
New Hampshire--------------	694	3,976	4,670
New Jersey-----------------	94	1,967	2,061
New York-------------------	200	15,445	15,645
Pennsylvania---------------	557	14,349	14,906
Rhode Island---------------	7	303	310
Vermont--------------------	275	3,931	4,206
West Virginia--------------	964	9,805	10,769
Total-----------------	3,241	72,990	76,231
North Central			
Illinois-------------------	340	3026	3,366
Indiana--------------------	364	3,533	3,897
Iowa-----------------------	26	1,483	1,509
Michigan-------------------	3,358	15,322	18,680
Minnesota------------------	2,980	13,807	16,787
Missouri-------------------	1,414	10,829	12,243
Ohio-----------------------	206	5,860	6,066
Wisconsin------------------	1,642	13,252	14,894
Total-----------------	10,330	67,112	77,442
Total for North----------------	13,571	140,102	153,673
South			
Southeast			
Florida--------------------	2,319	12,146	14,465
Georgia--------------------	1,498	21,567	23,065
North Carolina-------------	1,825	16,818	18,643
South Carolina-------------	757	10,770	11,527
Virginia-------------------	2,081	13,237	15,318
Total-----------------	8,480	74,538	83,018
South Central			
Alabama--------------------	840	19,792	20,632
Arkansas-------------------	2,661	14,069	16,730
Kentucky-------------------	936	10,645	11,581
Louisiana------------------	740	12,594	13,334
Mississippi----------------	1,299	14,416	15,715
Oklahoma-------------------	323	4,933	5,256

Table 3D-1--Federal and nonfederal forest land--Continued

	Federal 1/	Nonfederal 2/	Total
		(1,000 acres)	
Tennessee------------------	1,061	11,639	12,700
Texas----------------------	807	9,240	10,047
Total------------------	8,667	97,328	105,995
Total for South----------------	17,147	171,866	189,013
Rocky Mountain and Great Plains			
Great Plains			
Kansas----------------------	786	857	
Nebraska--------------------	45	439	484
North Dakota----------------	35	368	403
South Dakota----------------	1,057	333	1,390
Total------------------	1,208	1,926	3,134
Rocky Mountains			
Arizona---------------------	9,853	1,804	11,657
Colorado--------------------	14,961	3,343	18,304
Idaho-----------------------	16,978	4,229	21,207
Montana---------------------	16,324	6,343	22,667
Nevada----------------------	5,352	229	5,581
New Mexico------------------	10,559	3,426	13,985
Utah------------------------	11,446	1,066	12,512
Wyoming---------------------	8,523	1,163	9,686
Total-------------------	93,996	21,603	115,599
Total for Rocky Mountain and Great Plains-------------------	95,204	23,529	118,733
Pacific Coast			
Pacific Northwest			
Alaska----------------------	112,245	6,900	119,145
Oregon----------------------	18,698	10,062	28,760
Washington------------------	9,474	12,413	21,887
Total------------------	140,417	29,375	169,792
Pacific Southwest			
California------------------	18,819	9,857	28,676
Hawaii----------------------	0	1,443	1,443
Total-------------------	18,819	11,300	30,119
Total for Pacific Coast---------	159,236	40,675	199,911
Caribbean	28	428	456
Total for United States and Caribbean-----------------------	285,186	376,600	661,786

Source: 1/ USDA Forest Service. 1978. Forest Statistics of the U.S., 1977.
2/ 1977 National Resource Inventories

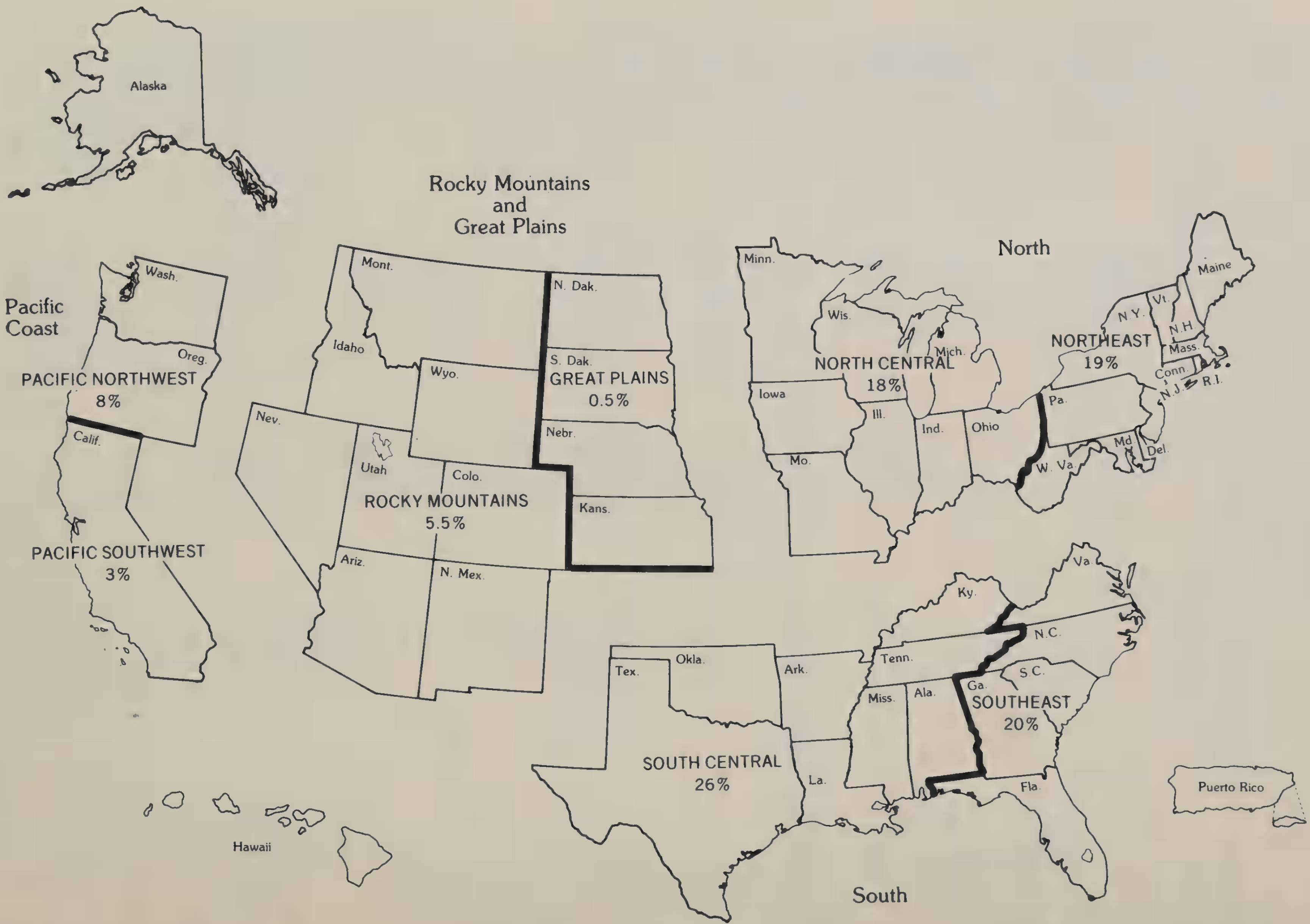

Figure 3D-1.--Percentages of nonfederal forest land, by region in 1977.

A wide diversity of major forest cover types occurs within each geographic region as well as between regions (table 3D-2). Douglas-fir, ponderosa pine, fir-spruce, and hemlock-sitka spruce are predominant cover types on nonfederal forest land in the Pacific Coast and Rocky Mountain regions. In the north, oak-hickory, maple beech-birch, spruce-fir, and elm-ash-cottonwood are the chief cover types. In the south, oak-hickory, loblolly-shortleaf pine, oak-pine, and oak-gum-cypress dominate.

Table 3D-2.--Major forest cover types of nonfederal forest land, by geographic region

North	South	Rocky Mountains and Pacific Coast
White-red-jack pine	Longleaf-slash pine	Douglas-fir
Spruce-fir	Loblolly-shortleaf pine	Ponderosa pine
Loblolly-shortleaf pine	Oak-pine	Western white pine
Oak-pine	Oak-hickory	Fir-spruce
Oak-hickory	Oak-gum-cypress	Hemlock-sitka spruce
Oak-gum-cypress	Elm-ash-cottonwood	Larch
Elm-ash-cottonwood		Lodgepole pine
Maple-beech-birch		Pinyon-juniper
Aspen-birch		Chaparral-mountain shrub
		Redwood

Source: USDA, Forest Service. 1978. Forest Statistics of the U.S., 1977.

Ownership.--Approximately 74 percent of the commercial nonfederal forest land is primarily under the control of farmers and other private owners (USDA, 1978). Commercial forest land is forest land that produces or can produce more than 20 cubic feet per acre per year of industrial wood under proper management and has not been withdrawn from timber utilization. Industry owns nearly 18 percent of this land, and state, county, and municipal governments own 8 percent. These percentages are expected to change when the state and native selections of federal land in Alaska have been completed. Nearly 30 percent of the noncommercial forest land is in nonfederal ownership. The largest part of this acreage is held by farmers and other private owners.

There are no data now on the number of owners of nonfederal forest land nationwide. Efforts are underway to compile this information in some parts of the country. In his talk "Tree Planting Gains and Goals in the United States" at the National Tree Planting Conference in 1972, John R. McGuire, Chief, USDA Forest Service, estimated that there are about 4 million private landowners of nonindustrial forest land in the Nation. Seventy-three percent of the commercial nonindustrial private forest land is in holdings of 500 acres or less, according to a 1976 unpublished paper "A Program for

Increasing Timber Supplies on Nonindustrial Private Forest Lands" by P. E. Hoekstra, J. K. Myers, and D. L. Green, Cooperative Forestry Staff. The average size is about 70 acres.

Productivity.--The potential productivity of nonfederal forest land for wood and herbage production can be measured easily. Yields of wood fiber are generally measured in cubic feet or board feet per acre per year. Herbage is measured in pounds per acre per year. It is more difficult to define the extent to which nonfederal forest land can sustain wildlife and recreation.

Potential productivity of nonfederal forest land is highly diverse. Soil, moisture, elevation, and topography not only influence the kind of vegetative cover but also determine the productive capability of an area to produce either wood fiber or herbage.

The potential productive capability of all forest land in the Nation averages 53 cubic feet of wood fiber per acre per year according to data assembled for the Resource Planning Act (RPA), 1980 Assessment, by the Forest Service, United States Department of Agriculture. The potential varies significantly among regions as well as within regions. The average potential in the East is 68 cubic feet per acre per year. In the West it is 37 cubic feet per acre per year, and ranges from 5 cubic feet per acre per year in the pinyon-juniper cover type to more than 200 cubic feet per acre per year in the Douglas-fir cover type (USDA, 1978b).

The potential productivity in the northeast region is quite variable. Approximately 8 percent of the forest land is capable of producing more than 120 cubic feet per acre per year. Nearly 27 percent can produce 85-120 cubic feet, and 36 percent can produce 50-85 cubic feet per acre per year. Twenty-five percent of the forest land has the potential for producing 50 or less cubic feet per acre per year.

In the Pacific Coast region 31 percent of the forest land is capable of producing more than 120 cubic feet per acre per year; only 6 percent of the forest land in the South region has this potential.

The average potential productivity of all forest industry commercial forest land is 87 cubic feet per acre per year. By region for this ownership group, the Pacific Coast ranks the highest with an average potential of 118 cubic feet per acre per year. The South is second with 82 followed by the North with 75 and the Rocky Mountains and Great Plains with 74 cubic feet per acre per year.

The average potential productivity for farm and other private ownerships is 72 cubic feet per acre per year. The Pacific Coast region is again the highest with an average of 100 cubic feet per acre per year followed by the South with 75 cubic feet per acre per year. The average potential for the North is 67, and for the Rocky Mountains and Great Plains it is 50 cubic feet per acre per year.

Potential herbage production on most nonfederal forest land ranges from 1,000 to 2,000 pounds per acre per year. In a given cover type such as hemlock-sitka spruce, however, the average potential herbage production is 4,200 pounds per acre per year.

Herbage production can vary within a cover type depending on the amount of canopy cover forming the overstory and the species in the understory. In the ponderosa pine cover type, herbage production under a sparse canopy cover ranges from 800-1,200 pounds per acre. Under a medium canopy cover production is 400-800 pounds per acre, and under a dense canopy cover production drops to 200-400 pounds per acre.

Use of Nonfederal Forest Land.--Nonfederal forest land can be used in widely varying ways to enhance the quality of life. It can supply basic raw materials such as wood fiber and herbage and provide water, wildlife, and recreation. Some uses have economic benefits, nationally and individually. Some are solely esthetic and enrich the cultural life of the people.

The actual use of these lands is as varied as are the interests of the people who own and manage them. Some lands are managed for a single given use and some for a combination of uses. Different uses of forest land can be highly compatible or can be in direct conflict, depending on the kind of use, the intensity of use, the location, and the level of management. Information on the use of nonfederal forest land for water, wildlife, and recreation can be found in other sections of this appraisal under their respective headings. Reliable information on all uses of nonfederal forest land, however, is often unavailable.

No accurate information is available on the number of nonfederal acres actually managed for the production of wood fiber. Information is available in the Forest Service publication "Forest Statistics of the U.S., 1977" on the amount of wood fiber products removed from these lands. Because of changes in ownership, market availability, and the resource, it is assumed that sooner or later nearly all of the 377 million acres of nonfederal forest land will contribute to wood fiber production.

In 1977, approximately 61 million acres of nonfederal forest land were grazed (table 3D-3). The South accounted for 43 percent of the acreage, the Rocky Mountain and Great Plains 24 percent, the North 19 percent, and the Pacific Coast 14 percent.

Condition

Growing Stock Inventory.--Nonfederal forest land supplies more than 57 percent of the inventory of growing stock in the Nation (USDA, 1978). It accounts for more than 82 percent of the hardwood inventory and 43 percent of the softwood inventory. Nearly 70 percent of the hardwood inventory is under farm and other private ownership.

Net Annual Growth.--Nonfederal owners account for more than 76 percent of the net annual growth of growing stock. In softwood they account for 71 percent, and in hardwoods 83 percent. In 1976, nearly 60 percent of the net annual growth was from land under farm or other private ownership (USDA, 1978).

The average net annual growth per acre on farm and other private land is 45 cubic feet. For the forest industry it is 59 cubic feet per acre per year. These figures on nonfederal forest land represent a dramatic increase in growth since 1952, almost two-thirds.

Table 3D-3.--Nonfederal forest land in 1977, grazed and ungrazed by region, subregion, and states

	Grazed	Ungrazed	Total
		(1,000 acres)	
North			
Northeast			
Connecticut-----	18	1,400	1,418
Delaware--------	1	359	360
Maine-----------	26	16,494	16,520
Maryland--------	78	2,082	2,160
Massachusetts---	37	2,719	2,756
New Hampshire---	32	3,944	3,976
New Jersey------	13	1,954	1,967
New York--------	608	14,837	15,455
Pennsylvania----	382	13,967	14,349
Rhode Island----	5	298	303
Vermont---------	116	3,815	3,931
West Virginia---	792	9,013	9,805
Total-------	2,108	70,882	72,990
North Central			
Illinois-------	600	2,426	3,026
Indiana--------	409	3,124	3,533
Iowa-----------	766	717	1,483
Michigan-------	333	14,989	15,322
Minnesota------	1,368	12,439	13,807
Missouri-------	3,816	7,013	10,829
Ohio-----------	741	5,119	5,860
Wisconsin------	1,554	11,698	13,252
Total------	9,587	57,525	67,112
Total for North---------	11,695	128,407	140,102
South			
Southeast			
Florida--------	2,973	9,173	12,146
Georgia--------	12	21,555	21,567
North Carolina-	735	16,083	16,818
South Carolina-	485	10,285	10,770
Virginia-------	1,100	12,137	13,237
Total------	5,305	69,233	74,538
South Central			
Alabama-------	1,621	18,171	19,792
Arkansas------	2,326	11,743	14,069
Kentucky------	1,424	9,221	10,645
Louisiana-----	3,215	9,379	12,594

Table 3D-3.--Nonfederal forest land in 1977, grazed and ungrazed by region, subregion, and states--Continued

	Grazed	Ungrazed	Total
		(1,000 acres)	
Mississippi---	2,332	12,084	14,416
Oklahoma------	3,332	1,601	4,933
Tennessee-----	1,596	10,043	11,639
Texas---------	4,883	4,357	9,240
Total-----	20,729	76,599	97,328
Total for South--------	26,034	145,832	171,866
Rocky Mountains and Great Plains			
Great Plains			
Kansas--------	325	461	786
Nebraska------	229	210	439
North Dakota--	150	218	368
South Dakota--	279	54	333
Total-----	983	943	1,926
Rocky Mountains			
Arizona------	1,382	422	1,804
Colorado-----	2,676	667	3,343
Idaho--------	1,843	2,386	4,229
Montana------	3,087	3,256	6,343
Nevada-------	169	60	229
New Mexico---	2,490	936	3,426
Utah---------	900	166	1066
Wyoming------	896	267	1,163
Total----	13,443	8,160	21,603
Total for Rocky Mountains and Great Plains-------------	14,426	9,103	23,529
Pacific Coast			
Pacific Northwest			
Alaska-------	-----	6,900	6,900
Oregon------	2,309	7,753	10,062
Washington--	2,637	9,776	12,413
Total---	4,946	24,429	29,375

Table 3D-3.--Nonfederal forest land in 1977, grazed and ungrazed by region, subregion, and states--Continued

	Grazed	Ungrazed	Total
	(1,000 acres)		
Pacific Southwest			
California--	3,775	6,082	9,857
Hawaii------	156	1,287	1,443
Total---	3,931	7,369	11,300
Total for Pacific Coast----------------	8,877	31,798	40,675
Caribbean-----------	23	405	428
Total for United States---------------	61,055	315,545	376,600

Source: 1977 National Resource Inventories

Even though these increases in net annual growth are significant, they are still below productive potential. Farm and other private owners are producing at only 63 percent of their potential. The forest industry is producing at 68 percent of its potential.

Removals.--Overall net growth of hardwoods has substantially exceeded removals. In some parts of the Nation, however, such as in the bottomland hardwood area of the South where extensive clearing has taken place, net growth has been less than removals. More than 70 percent of all softwood removals in 1976 was from nonfederal forest land under private ownership (USDA, 1978). The net growth of softwoods has also exceeded removals but to a lesser extent than hardwoods.

Growing stock inventories, net annual growth, and removals are discussed in more detail under "Timber" in the Resources Planning Act (RPA), 1980 Assessment, compiled by the Forest Service.

Sheet and Rill Erosion.--The estimated average annual sheet and rill erosion on all nonfederal forest land in 1977 was 1.18 tons per acre (table 3D-4). The average for all grazed nonfederal forest land was significantly higher, 3.97 tons per acre. The average for ungrazed forest land was only 0.63 tons per acre.

The figures on the average rate of sheet and rill erosion for a given state must be used with caution. The average for a state may be within acceptable limits, but a specific site within that state may have a sheet and rill erosion rate that far exceeds tolerable limits.

On grazed forest land, the erosion rate was lower than 2 tons per acre per year in 22 states, 2 to 5 tons in 11 states, 5 to 10 tons in 10 states, and more than 10 tons in 6 states. Delaware has no grazed forest land. Rates of sheet and rill erosion for Alaska are not available.

Grazed forest types are generally more open and have less ground cover than ungrazed forest types. The ponderosa pine type in particular has more exposed soil in old scattered stands, recent cutover, and low sites. This is especially true on granitic soils and those with low base saturation.

On the ungrazed forest land, 36 states reported sheet and rill erosion of less than 1 ton per acre per year, 11 states a loss of 1 to 2 tons, and 2 states a loss of 2 to 5 tons. The Caribbean area reported the highest soil loss through sheet and rill erosion -- 9.69 tons per acre per year.

The average rate of sheet and rill erosion on nonfederal forest land was highest in land capability classes VII and VIII, at 2.53 tons per acre per year (table 3D-5). The highest rate in classes II-VI was subclass e. Next to the highest was subclass s. The lowest average annual rates were for subclasses c and w.

Sheet and rill erosion caused more than 437 million tons of soil erosion on nonfederal forest land in 1977 (table 3D-4). The amount of soil movement through sheet and rill erosion does not directly equal the amount of sediment deposited in a stream because much of the sediment is deposited on the

Table 3D-4.--Estimated average annual sheet and rill erosion in 1977 on nonfederal forest land, by state

State	Forest land grazed		Forest land not grazed		Total forest land	
	1,000 tons/yr	Tons/ac/yr	1,000 tons/yr	Tons/ac/yr	1,000 tons/yr	Tons/ac/yr
Alabama---------	3,197	1.97	12,080	0.67	15,277	0.77
Arizona---------	10,350	7.49	512	1.21	10,862	6.02
Arkansas--------	32,524	13.98	8,763	.75	41,287	2.93
California------	22,117	5.86	7,300	1.20	29,417	2.98
Colorado--------	18,790	7.02	662	.99	19,452	5.82
Connecticut-----	14	.78	350	.25	364	.26
Delaware--------	0	0	17	.05	17	.05
Florida---------	843	.28	790	.09	1,633	.13
Georgia---------	159	13.25	6,498	.30	6,657	.31
Hawaii----------	1,833	11.75	4,133	3.21	5,966	4.13
Idaho-----------	660	.36	262	.11	922	.22
Illinois--------	10,281	17.14	1,536	.63	11,817	3.91
Indiana---------	2,205	5.39	2,862	.92	5,067	1.43
Iowa------------	3,373	4.40	742	1.04	4,115	2.77
Kansas----------	1,963	6.04	383	.83	2,346	2.98
Kentucky--------	11,719	8.23	14,789	1.60	26,508	2.49
Louisiana-------	2,187	.68	1,488	.16	3,675	0.29
Maine-----------	2	.08	1,277	.08	1,279	.08
Maryland--------	262	3.36	1,257	.60	1,519	.70
Massachusetts---	20	.54	1,423	.52	1,443	.52
Michigan--------	1,086	3.26	787	.05	1,873	.12
Minnesota--------	5,166	3.78	1,433	.12	6,599	.48
Mississippi------	4,017	1.72	8,300	.69	12,317	.85
Missouri---------	30,219	7.92	11,856	1.69	42,075	3.89
Montana----------	7,702	2.50	2,564	.79	10,266	1.62
Nebraska---------	1,141	4.98	329	1.57	1,470	3.35
Nevada-----------	334	1.98	110	1.83	444	1.94
New Hampshire----	47	1.47	557	.14	604	.15
New Jersey-------	12	.92	418	.21	430	.22
New Mexico-------	3,642	1.46	363	.39	4,005	1.17
New York---------	1,074	1.77	8,294	0.56	9,368	0.61
North Carolina---	622	.85	1,706	.11	2,328	.14
North Dakota-----	44	.29	7	.03	51	.14

Table 3D-4.--Estimated average annual sheet and rill erosion in 1977 on nonfederal forest land, by state--Continued

State	Forest land grazed		Forest land not grazed		Total forest land	
	1,000 tons/yr	Tons/ac/yr	1,000 tons/yr	Tons/ac/yr	1,000 tons/yr	Tons/ac/yr
Ohio------------	8,891	12.00	5,827	1.14	14,718	2.51
Oklahoma--------	6,392	1.92	1,451	.91	7,843	1.59
Oregon----------	1,418	.61	2,359	.30	3,777	.38
Pennsylvania----	1,804	4.72	12,910	.92	14,714	1.03
Rhode Island----	2	.40	50	.17	52	.17
South Carolina--	241	.50	1,718	.17	1,959	.78
South Dakota----	712	2.55	58	1.07	770	2.31
Tennessee-------	3,515	2.20	11,822	1.18	15,377	1.32
Texas-----------	2,195	.45	998	.23	3,193	.35
Utah------------	4,422	4.91	113	.68	4,535	4.25
Vermont---------	429	3.70	1,774	.47	2,203	.56
Virginia--------	6,682	6.08	13,982	1.15	20,664	1.56
Washington------	4,064	1.54	2,439	.25	6,503	.52
West Virginia---	9,242	11.67	27,165	3.01	36,407	3.71
Wisconsin-------	11,229	7.23	4,209	.36	15,438	1.16
Wyoming---------	3,589	4.01	248	.93	3,837	3.30
Caribbean-------	146	6.35	3,924	9.69	3,070	9.51
Total-------	242,578	3.97	194,895	.63	437,473	1.18

1/ No data available for Alaska.
Source: 1977 National Resource Inventories

Table 3D-5.--United States summary of estimated average annual sheet and rill erosion on 1977 nonfederal forest land, by land capability class and subclass

Class and subclass	Forest land grazed		Forest land not grazed		Total forest land	
	1,000 tons/yr	Tons/ac/yr	1,000 tons/yr	Tons/ac/yr	1,000 tons/yr	Tons/ac/yr
I	97	0.40	180	0.11	277	0.14
IIe	1,858	.66	2,489	.13	4,347	.20
IIw	924	.48	697	.05	1,621	.10
IIs	43	.17	218	.08	261	.08
IIc	18	.14	22	.04	40	.06
IIIe	6,327	1.42	7,240	.30	13,567	.47
IIIw	709	.24	1,112	.06	1,821	.08
IIIs	2,332	1.94	1,518	.24	3,850	.51
IIIc	2	.04	0	0	2	.02
IVe	14,025	3.12	11,435	.52	25,460	.96
IVw	508	.27	620	.03	1,128	.05
IVs	9,393	6.98	3,682	.35	13,075	1.10
IVc	16	.15	6	.06	22	.10
V	677	.25	594	.04	1,271	.08
VIe	45,467	3.96	31,058	.92	76,525	1.69
VIw	91	.20	134	.02	225	.04
VIs	10,338	3.54	8,729	.30	19,067	.60
VIc	36	.38	40	.30	76	.33
VII - VIII	149,717	6.93	125,121	1.44	274,838	2.53
Total	242,578	3.97	194,895	.63	437,473	1.18

Source: 1977 National Resource Inventories

slope before it reaches a channel (Dissmeyer and Stump, 1978). Estimates show that only about one-fourth of the sediment moved annually by flowing water in the United States reaches major streams (Wischmeier and Smith, 1978).

Gully, Logging Road, Skid Trail, and Streambank Erosion.--Gullies, logging roads, skid trails, and streambanks are often referred to as the principal contributors of soil erosion from forest land. There is currently no national inventory that can express the magnitude of the soil erosion problem from these sources. Local studies have been made, however, that can indicate to some extent the problem within a respective area.

One study in the South indicated that the amount of sediment from skid trails and spur roads in eight river basin areas ranged from as low as 2 to as high as 54 percent of all erosion on forest land (Dissmeyer, 1976).

Flood Prone Areas.--Nonfederal forest land occupies 51 million acres that are prone to flooding. The South region accounts for more than 37 million acres of nonfederal forest land that are flood prone. The North region is second with more than 12 million acres (table 3D-6).

Trends

Area.--The area of nonfederal forest land has been decreasing since 1952. Most of the loss occurred as areas were converted to cropland, pasture, and urban land.

During the 1980's the loss of forest land to cropland is expected to continue. After 1990, however, most of the loss of forest land will probably result from urban expansion and other uses such as reservoirs, highways, and airport construction.

While the overall trend has been a decrease in the area of nonfederal forest, there can be significant shifts from one land use to another within a short time span. The Potential Cropland Study (USDA, 1977) conducted by the Soil Conservation Service examined changes in land use between 1967 and 1975. During this 8-year period, 14 percent of the forest land was shifted to pasture and range, 2 percent to cropland, 3 percent to other land, and 2 percent to water and urban uses. The total gross loss was 21 percent. During this same period, however, there were shifts to forest land--2 percent from cropland, 3 percent from pasture and range, and 1 percent from other land uses. The total shift to forest reduced the total loss from 21 percent to 15 percent.

Table 3D-6.--Flood prone areas in 1977, on nonfederal forest land and all nonfederal land, by region, subregion, and state

	Forest land	All flood prone land
	(1,000 acres)	
North		
Northeast		
Connecticut	109	183
Delaware	51	137
Maine	601	1,176
Maryland	213	505
Massachusetts	345	573
New Hampshire	184	295
New Jersey	224	383
New York	602	1,417
Pennsylvania	782	1,565
Rhode Island	58	67
Vermont	72	195
West Virginia	112	482
Total	3,353	6,978
North Central		
Illinois	731	3,802
Indiana	410	2,202
Iowa	287	2,884
Michigan	2,035	3,409
Minnesota	2,366	10,513
Missouri	987	6,256
Ohio	494	1,912
Wisconsin	1,511	3,812
Total	8,821	34,790
Total for North	12,174	41,768
South		
Southeast		
Florida	4,912	9,330
Georgia	6,440	7,744
North Carolina	3,634	4,741
South Carolina	1,913	2,588
Virginia	912	1,639
Total	17,811	26,042

Table 3D-6.--Flood prone areas in 1977, on nonfederal forest land and all nonfederal land, by region, subregion, and state--Continued

	Forest land	All flood prone land
	(1,000 acres)	
South Central		
Alabama	3,776	5,174
Arkansas	2,985	6,116
Kentucky	389	1,994
Louisiana	4,723	10,214
Mississippi	4,173	9,532
Oklahoma	438	5,333
Tennessee	1,074	3,440
Texas	2,117	18,407
Total	19,675	60,210
Total for South	37,486	86,252
Rocky Mountains and Great Plains		
Great Plains		
Kansas	404	5,540
Nebraska	242	4,621
North Dakota	99	1,937
South Dakota	20	2,148
Total	765	14,246
Rocky Mountains		
Arizona	0	6,180
Colorado	42	2,476
Idaho	47	1,006
Montana	276	4,410
Nevada	0	1,770
New Mexico	1	3,949
Utah	16	1,149
Wyoming	77	2,014
Total	459	22,954
Total for Rocky Mountain and Great Plains	1,224	37,200

Table 3D-6.--Flood prone areas in 1977, on nonfederal forest land and all nonfederal land, by region, subregion, and state--Continued

	Forest land	All flood prone land
	(1,000 acres)	
Pacific Coast		
Pacific Northwest		
Alaska 1/	----	----
Oregon	112	2,083
Washington	323	1,375
Total	435	3,458
Pacific Southwest		
California	147	6,059
Hawaii	114	151
Total	261	6,210
Total for Pacific Coast	696	9,668
Caribbean	0	176
Total for United States	51,580	175,064

1/ Data for Alaska unavailable.
Source: 1977 National Resources Inventories

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Section E-Mined Land

Status

Surface mining occurs in all states. It affects a wide range of soils, vegetation, ecosystems, and climatic zones. The acreage disturbed, however, is a small percentage of our total land area. Paone et al. (1974) reported that land utilized by mining from 1930 to 1971 amounted to 0.16 percent of the land mass of the United States. However, mining is geographically concentrated and this results in intense hydrologic and esthetic changes in specific environments. These changes, in turn, often affect an area larger than the area that has been physically disturbed.

As of July 1, 1977, the mineral industry had disturbed 5.7 million acres in the United States. Table 3E-1 shows the status of that disturbed land in each state. Exactly how much additional land is disturbed annually is not known, but it can be estimated. Based on data reported by producers, the U.S. Department of the Interior (USDI) estimated that 153,000 acres of land were disturbed in 1964 by strip and surface mining (USDI, 1967). Sand and gravel accounted for 60,000 acres; coal, 46,000; stone, 21,000; clay, 9,000; phosphate rock, 9,000; and the remaining minerals accounted for 8,000 acres.

Paone et al. (1974) reported that between 1930 and 1971 the percentages of the land surface mined for various commodities were as follows:

Phosphate rock	2 percent
Iron ore	3 percent
Clay	5 percent
Copper	5 percent
Stone	14 percent
Sand and gravel	18 percent
Bituminous coal	40 percent
All other commodities	13 percent

Paone and Meyer (1978) reported on the extent of our nonrenewable commodities and the extent to which they were surface mined in 1975. In 1975, surface mining accounted for 96 percent of domestic production of nonmetallic ores, 88 percent of metallic ores, and 55 percent of coal. Table 3E-2 breaks down surface mining in 1975 by commodities.

Table 3E-1.-- Status of land disturbed by surface mining in the United States as of July 1, 1977, by states 1/

[Acres; dashes indicate none]

State	Land needing reclamation: Reclamation not required by any law: Coal mines	Sand and gravel	Other mined areas	Reclamation required by law: Coal mines	Sand and gravel	Other mined areas	Land not requiring reclamation	Total land disturbed
Alabama	72,292	16,611	19,929	34,807	5,498	6,252	85,673	241,062
*Alaska	2,700	4,300	4,000	---	---	---	4,000	15,000
*Arizona	400	6,400	60,900	---	---	---	121,800	189,500
Arkansas	5,623	21,483	11,479	2,859	20	1,592	9,449	52,505
California	10	7,970	80,998	500	17,642	51,316	59,061	217,497
*Caribbean Area	---	2,550	1,000	---	---	---	710	4,260
Colorado	7,089	8,334	15,861	1,195	11,672	6,513	14,023	64,687
*Connecticut	---	16,740	787	---	---	---	4,590	22,117
*Delaware	---	2,912	63	---	---	---	1,498	4,473
Florida	---	11,162	235,700	---	3,365	20,922	61,266	332,415
Georgia	1,680	3,353	24,008	764	4,623	13,772	23,247	71,447
Hawaii	---	15	115	---	---	---	---	130
Idaho	---	5,100	1,500	---	18,200	3,500	2,500	30,800
Illinois	118,711	20,330	14,192	40,899	8,582	4,557	88,860	296,131
Indiana	25,882	11,875	6,522	74,581	4,176	1,894	64,711	189,641
Iowa	13,997	10,147	6,421	341	8,457	9,638	10,519	59,520
Kansas	41,256	11,150	10,159	815	3,634	3,978	20,117	91,109
Kentucky	101,637	980	4,712	154,218	2,299	2,780	154,495	421,121
*Louisiana	---	37,324	2,549	---	---	---	10,467	50,340
Maine	---	28,833	2,075	---	2,293	923	6,794	40,918
Maryland	6,412	7,430	1,181	5,703	9,741	1,734	19,824	52,025
*Massachusetts	---	32,041	10,330	---	---	---	11,750	54,121
Michigan	142	39,424	23,422	---	15,662	4,072	27,600	110,322
Minnesota	---	30,047	44,801	---	12,444	7,891	66,919	162,102
*Mississippi	---	45,966	7,821	---	---	---	14,415	68,202
Missouri	70,688	4,473	28,187	8,772	1,046	6,055	22,051	141,272
Montana	1,955	4,655	18,340	4,766	4,492	6,598	12,528	53,334
*Nebraska	---	17,969	4,029	---	---	---	11,005	33,003
*Nevada	---	1,221	2,555	---	---	---	1,953	5,729
*New Hampshire	---	12,725	417	---	---	---	547	13,689
*New Jersey	---	24,610	5,570	---	---	---	8,263	38,443
New Mexico	22	11,860	1,806	3,709	1,057	26,072	2,207	46,733
New York	---	30,917	19,251	---	15,979	5,037	18,477	89,661
North Carolina	---	11,908	4,792	---	7,096	3,909	7,000	34,705
North Dakota	1,050	2,010	200	6,725	---	---	38,595	48,580
Ohio	196,709	22,621	18,923	77,050	16,659	8,427	190,578	530,967

Table 3E-1.-- Status of land disturbed by surface mining in the United States as of July 1, 1977, by states (continued) 1/

[Acres; dashes indicate none]

State	Land needing reclamation: Reclamation not required by any law: Coal mines	Sand and gravel	Other mined areas	Reclamation required by law: Coal mines	Sand and gravel	Other mined areas	Land not requiring reclamation	Total land disturbed
Oklahoma	36,118	6,659	14,105	6,298	2,766	4,110	16,255	86,311
Oregon	---	3,521	17,568	3	6,814	1,538	7,387	36,831
Pennsylvania	240,000	11,000	20,500	60,000	15,000	25,000	250,000	621,500
*Rhode Island	---	2,592	---	---	---	---	3,470	6,062
South Carolina	---	9,065	2,128	---	4,395	3,194	9,815	28,597
South Dakota	890	10,153	5,259	---	6,826	695	7,149	30,972
Tennessee	29,583	4,950	2,305	3,127	810	1,135	104,596	146,506
Texas	3,310	152,457	37,104	3,725	6,289	4,989	48,456	256,330
Utah	635	3,999	4,414	133	4,637	10,216	7,521	31,555
Vermont	---	3,877	2,078	---	377	60	1,536	7,928
Virginia	23,724	3,788	1,251	8,222	3,929	2,003	70,060	112,977
Washington	48	9,701	8,174	1,190	11,822	1,073	10,245	42,253
West Virginia	84,868	4,554	995	7,658	---	---	137,105	235,180
Wisconsin	---	41,607	7,555	---	11,884	2,865	21,605	85,516
Wyoming	9,657	3,673	12,376	62,028	7,665	12,787	5,511	113,697
Total	1,097,088	799,042	830,407	570,088	257,851	267,097	1,898,203	5,719,776

1/Based on information from Soil Conservation Service state offices
*No state law when survey completed; therefore, no reclamation required by law

Table 3E-2.--Commodities surface mined in 1975

Crude ore commodity	Million short tons	Percentage recovered by surface mining
Clay	43	98
Coal, bituminous	356	55
Copper	240	89
Iron ore	230	96
Phosphate rock	186	100
Sand and gravel	789	100
Stone	867	96
All other commodities	95	50
Total	2,806	86

"Strippable Reserves of Bituminous Coal and Lignite in the United States" (USDI, 1971) provides information on the location of strippable coal reserves in the conterminous United States by region. Figure 3E-1 shows the location of these reserves.

Condition

There are 5.7 million acres of land disturbed by mining. There is no legal requirement to reclaim 2.7 million acres of unreclaimed mined land. (Eleven states and the Caribbean area did not have reclamation laws in effect when SCS conducted its 1977 survey of surface-mined land.) Reclamation is required by law on approximately 1.1 million acres that have not yet been reclaimed. According to this 1977 SCS survey, approximately 1.9 million acres of land disturbed by mining have been reclaimed by natural seeding or through the efforts of landowners.

The 2.7 million acres that do not have to be reclaimed by law are made up of about 1.1 million acres affected by coal mines, 800,000 affected by sand and gravel mining, and more than 800,000 mined for other commodities. Of the 1.1 million acres that must be reclaimed by law, more than 570,000 acres were affected by coal mining, more than 257,000 by sand and gravel mining, and more than 267,000 by mining for other commodities.

Location.--Abandoned coal-mined lands are concentrated primarily in the eastern and interior coal provinces. Pennsylvania has 240,000 acres of abandoned coal-mined land that need reclamation and are not covered by any law. This is the largest state acreage. Other states having high acreages of unreclaimed coal-mined lands that are not covered by reclamation laws are:

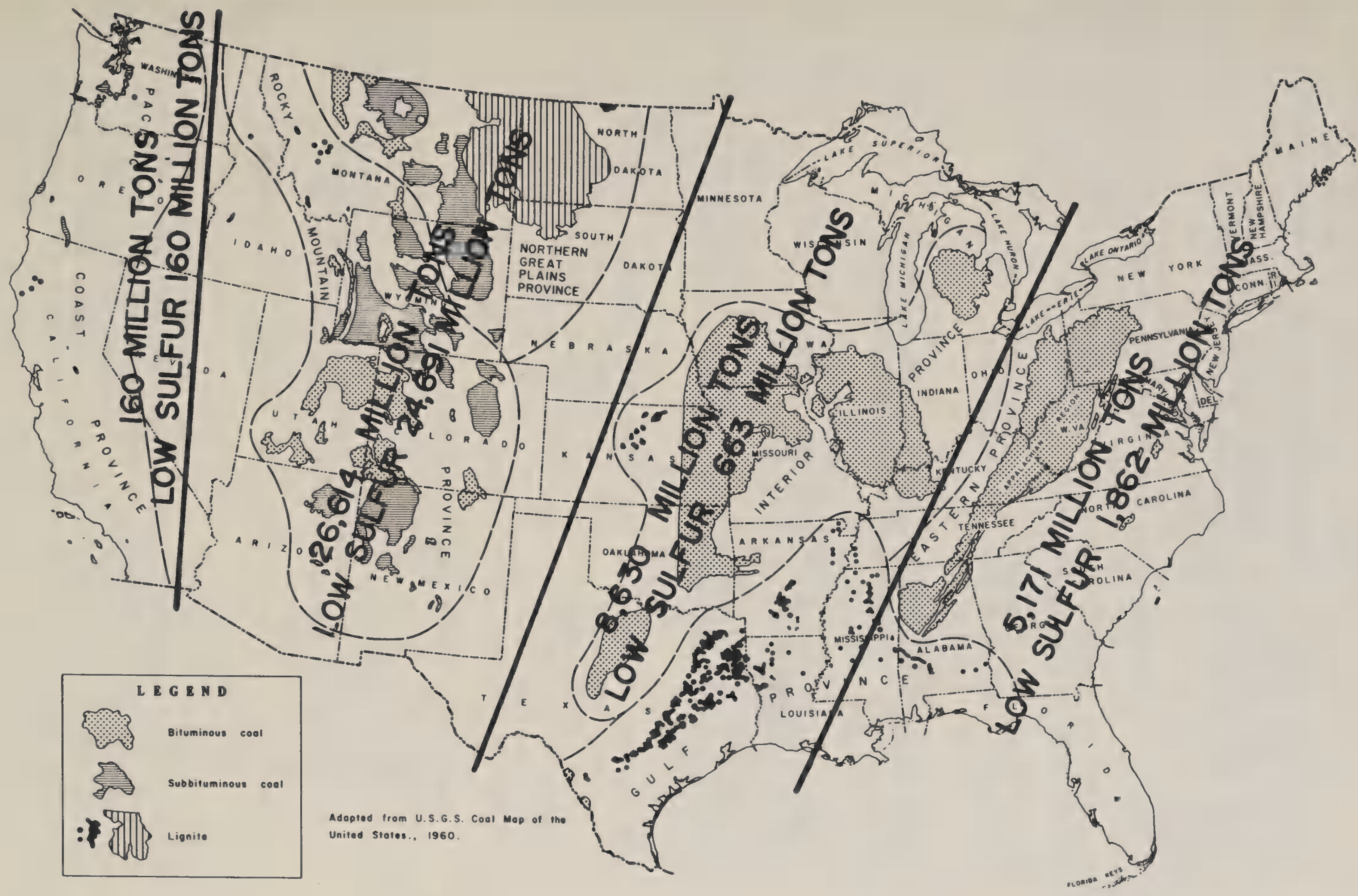

Figure 3E-1.--Strippable coal reserves of the conterminous United States, by region.

Ohio--196,700 acres; Illinois--118,700 acres; Kentucky--101,600 acres; West Virginia--84,900 acres; Alabama--72,300 acres; Missouri--70,700 acres; Kansas--41,300 acres; Oklahoma--36,100 acres; Tennessee--29,600 acres; Indiana--25,900 acres; Virginia--23,700 acres; Iowa--14,000 acres. These 12 states contain more than 96 percent of the abandoned coal-mined land in the United States.

Most of the other abandoned sites are the result of sand and gravel, stone, phosphate, iron, clay, and gold mining. The Minerals Yearbook (USDI, 1974) and the Bureau of Mines Commodity and Data Summaries (USDI, 1977a) report recent production of these commodities as follows:

Crushed stone was produced in every state except Delaware. Principal producing states are Pennsylvania, Illinois, Texas, Florida, and Ohio.

Dimension stone was produced in 44 states. Georgia, Indiana, Ohio, Pennsylvania, and Vermont accounted for about half the total.

Phosphate is concentrated in Florida (78 percent of the country's production).

Iron ore was mined mostly in Minnesota and Michigan, which accounted for 64 percent and 20 percent, respectively, of the 1976 production.

Clay in one or more of the categories (kaolin, ball clay, fire clay, bentonite, fuller's earth or common clay, and shale) was produced in 47 states. However, specific categories of clay are concentrated in certain states. The major producing states are:

- Kaolin--Georgia, 75 percent, and South Carolina, 12 percent.
- Ball clay--Tennessee, 61 percent.
- Fire clay--Ohio, Pennsylvania, Missouri, and Alabama, 97 percent.
- Bentonite--Generally, high-swelling or sodium bentonites are produced in Wyoming, Montana, and South Dakota. The calcium or low-swelling bentonites are produced in other states.
- Fuller's earth--Georgia, 40 percent, and Florida, 34 percent.

Gold accounted for 6 percent of the land disturbed by surface mining as of January 1, 1965. Domestic gold production has declined in recent years. In 1976, approximately 36 percent was produced as a byproduct of base-metal mining operations, chiefly copper. In 1976, South Dakota, Nevada, Utah, Arizona, Colorado, Washington, and Montana accounted for 96 percent of the total production.

Bauxite is produced primarily in Arkansas, 86 percent. The rest is produced in Alabama and Georgia.

Adjacent Areas.--The total acreage affected by surface mining varies with the topography, mining and processing methods, climate, and the geology of the area. Contour mining in hilly topography disturbed 696,000 acres (24 percent) of the privately owned surface-mined lands in 1965. In eastern Kentucky, haul roads accounted for about 10 percent of the land disturbed. Generally, there is also damage to hillsides below mining operations. This occurs more in contour mining than in area mining or open-pit mining.

Calculating the Acreage Disturbed.--A National Academy of Sciences Study (1974) showed the relation between coal seam thickness and the number of acres disturbed per million tons mined. Figure 3E-2 shows this relationship and indicates the average thickness of coal reserves in the western states.

The "Report of the Interagency Task Force on the Issue of a Moratorium or a Ban on Mining in Prime Agricultural Lands," (1977, unpublished) provides information on the acres disturbed by surface mining in 1977. This report was prepared by the Office of Management and Budget; Soil Conservation Service; Bureau of Mines; Federal Energy Administration; and the Environmental Protection Agency. They estimated that 47,716 acres would be mined for coal in 1977. Table 3E-3 gives estimates of the total acreage disturbed in primary producing states. The total acreage affected, however, would be twice the amounts indicated, about 95,000 acres, because of haul roads, damage to hillsides in contour mining, acid mine drainage, and other offsite effects.

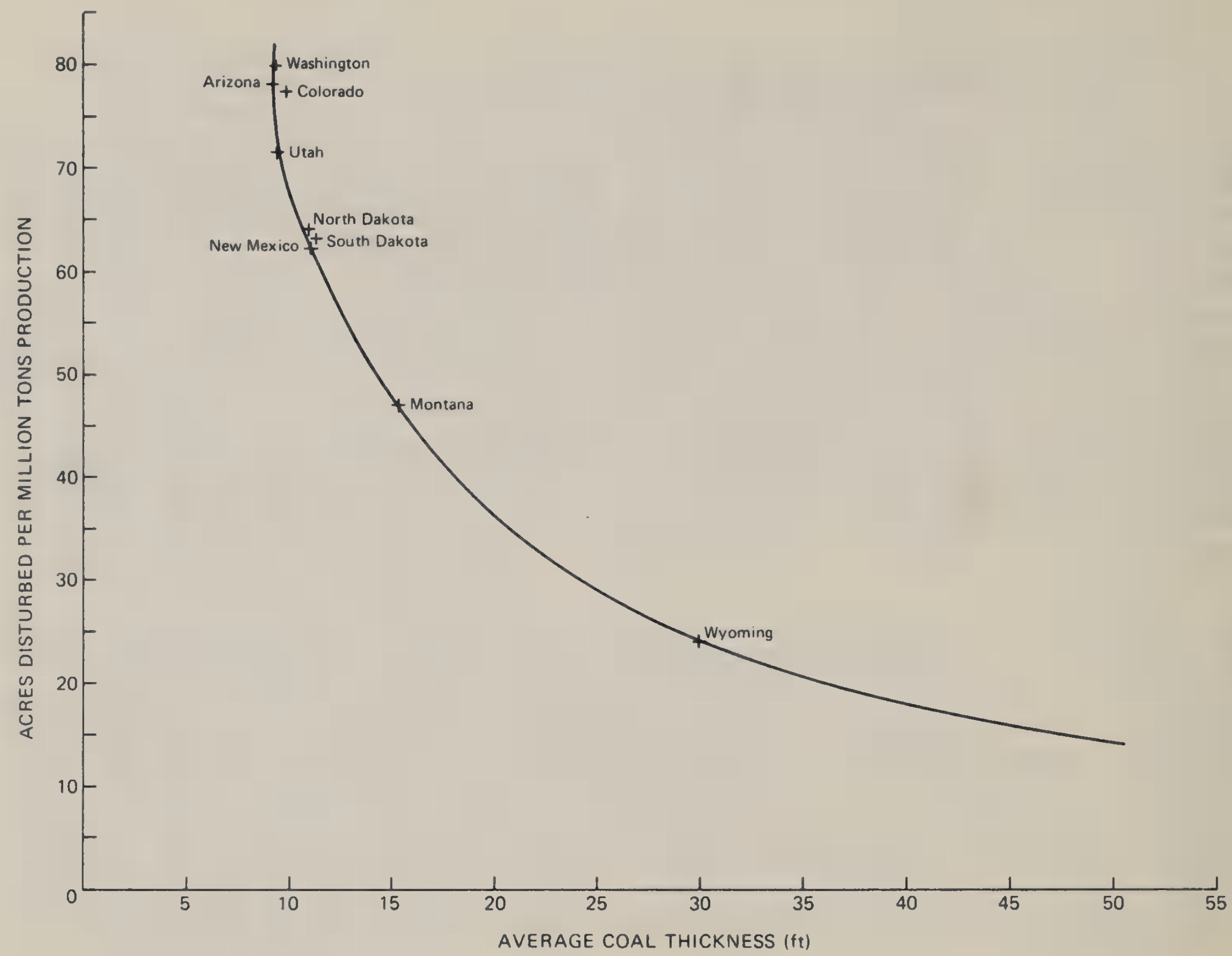

Figure 3E-2.--Relationship of coal seam thickness to acres disturbed, per million tons production. (Assumed: 1,750 tons per acre-foot, 80% recovery.) (National Academy of Sciences, 1974)

Table 3E-3.--Estimated acreage disturbed by surface coal mine production (1977)

State	Average seam thickness (ft)	1977 strip mine coal production 1/	Total acreage mined
Alabama	2.1	14,450	3,822
Alaska	10.0	790	43
Arizona	10.0	10,550	586
Arkansas	2.3	670	587
Colorado	12.0	6,450	297
Illinois	3.4	30,050	4,910
Indiana	4.0	26,750	3,715
Iowa	3.0	290	53
Kansas	1.8	980	302
Kentucky	3.5	78,890	12,522
Maryland	3.0	2,680	496
Missouri	2.0	5,390	1,497
Montana	24.0	32,970	763
New Mexico	11.0	11,270	569
North Dakota	16.0	14,130	490
Ohio	4.0	28,040	3,894
Oklahoma	2.0	2,770	769
Pennsylvania	3.6	34,950	5,393
Tennessee	3.2	5,170	897
Texas	7.0	15,610	1,238
Virginia	3.5	11,800	1,873
Washington	22.0	3,700	93
West Virginia	4.3	19,850	2,564
Wyoming	67.0	41,400	343
Total		399,600	47,716 2/

1/ Bituminous and lignite.

2/ To obtain the total acreage affected by surface mining, multiply this figure by two to account for secondary impacts such as haul roads and other facilities.

Trend

Table 3E-4 shows nationwide changes in the status of surface-mined land between 1965 and 1977. The average rate of land disturbance was 202,000 acres per year. The total number of acres reclaimed by 1977 is about the same as it was in 1974. Additional acres were reclaimed between 1974 and 1977, but our guidelines on what is adequately reclaimed are more stringent now than they were in 1974.

Table 3E-4.--Status of land disturbed by surface mining in the United States from January 1, 1965, to July 1, 1977

Status of mined land	1965 1/	1972 2/	1974 3/	1977 4/
Land requiring reclamation------	2,040.6	2,181.2	2,542.7	3,821.6
Land not requiring reclamation--	1.147.2	1.823.7	1,876.0	1,898.2
Total land disturbed------------	3,187.8	4,004.9	4,418.7	5,719.8

1/ Surface mining and our environment--a special report, (USDI 1967) appendix 1, table 2.

2/ Restoring surface-mined land (USDA, 1973) table 2, p. 3.

3/ SCS 1974 survey reported in the Congressional Record, April 8, 1974, table 1, p. E 2815.

4/ 1977 SCS survey.

Paone et al. (1974) reported on land use and reclamation by the mining industry. They obtained data from operating companies, mining organizations, appropriate state agencies, and others concerned with such activities. From 1930 through 1971, the mining industry disturbed 3.65 million acres, or 0.16 percent of the land mass of the United States. A survey made by SCS in 1971 showed 4 million acres disturbed. This SCS survey also included land mined before 1930, which may account for its higher estimate. According to Paone et al. (1974), the 10 leading states in land used for mining in 1971 were, in order: Kentucky, Pennsylvania, Arizona, Ohio, California, Florida, West Virginia, Illinois, Minnesota, and Indiana. Paone also reported on reclamation over the period 1930 through 1971. The fossil fuels industry reclaimed more than 1 million acres, or 69 percent of the total land reclaimed. Land mined for nonmetals accounted for 28 percent of the reclaimed land and metals 3 percent. The largest single item of reclamation, about one-half the total area reclaimed, was land mined for bituminous coal. As used by Paone, "reclaimed" indicates that reconditioning or restoration work has been completed on mined areas and waste disposal areas in compliance with federal, state, and local laws. If reclamation was not required by law, Paone asked operators to report the affected areas that they felt were reconditioned or restored to a useful condition.

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Chapter 4 - Prime Farmland

Quality

Prime farmland is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when it is treated and managed using acceptable farming methods. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland can be land used for cropland, pastureland, rangeland, forest land, or other land, but not for urban and built-up land or for water areas. It must either be used for producing food or fiber or be available for these uses.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. In general, it also has favorable temperature and growing season, acidity and alkalinity, and salt and sodium content. It has few or no rocks and is permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods and is not flooded during the growing season. The slope ranges mainly from 0 to 5 percent. A detailed discussion of the criteria for prime farmland is available in the Federal Register (Vol. 43, No. 21--Tuesday, January 31, 1978).

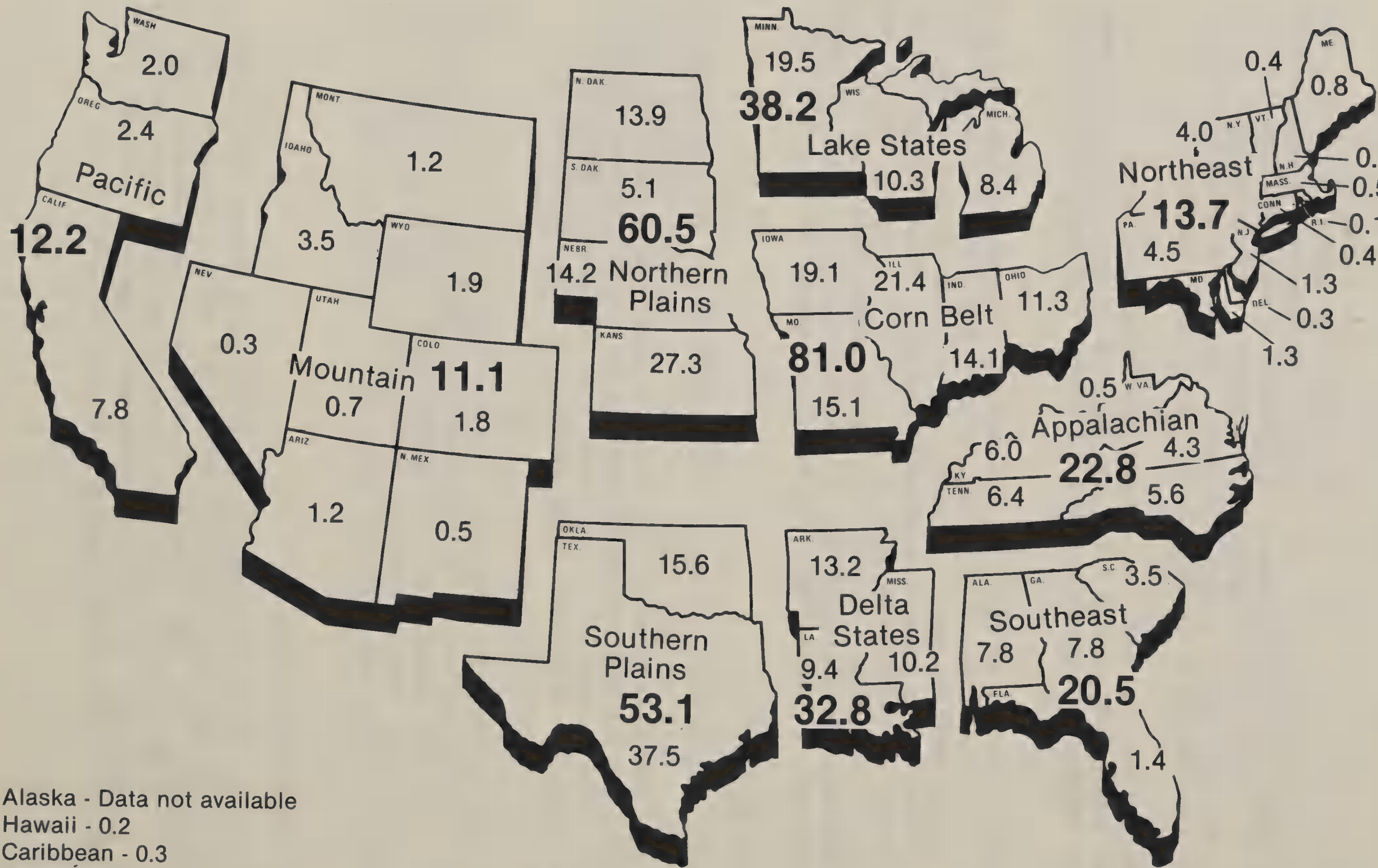
Amount of Prime Farmland

There are about 346 million acres of prime farmland in the United States excluding Alaska. Most of this land is in the Corn Belt, followed by the Northern Plains, the Lake States, and the Southern Plains, in that order. Figure 4-1 shows the acreage of prime farmland by state and farm production region in 1977. The amount of prime farmland in each state varies greatly, ranging from a high of 38 million acres in Texas to a low of 81,000 acres in Rhode Island.

From 1967 to 1975, about 8 million acres of prime farmland were lost to other uses (Schmude, 1977). This prime farmland was converted from cropland, pastureland, rangeland, forest land, and other rural uses at an average rate of 1 million acres per year. Of this 8 million acre loss, 6.5 million acres were converted to urban and built-up areas and 1.5 million acres to water areas.

Contributions to Food and Fiber

About two-thirds of the prime farmland, or 230 million acres, was cropped in 1977. This accounts for more than half of the 413 million acres of cropland in the United States. Of the 116 million acres of prime farmland that are not cropped, 42 million acres are forest land, 40 million acres are native pastures and pastureland, 23 million acres are rangeland, and 11 million acres are farmsteads, farm roads, feedlots, or similar land.



Alaska - Data not available
Hawaii - 0.2
Caribbean - 0.3
Total - 346.5

Source: 1977 National Resource Inventories
Table G1

Figure 4-1.--Prime farmland in 1977, by state and farm production region (millions of acres).

The percentage of prime farmland used for crops varies widely from state to state. States using more than 90 percent of their prime farmland for crops are Arizona, Colorado, New Mexico, North Dakota, and Utah. Except in North Dakota, practically all of the prime farmland in these states is irrigated.

States using 80 to 90 percent of their prime farmland for crops are California, Hawaii, Idaho, Illinois, Indiana, Iowa, Nebraska, Nevada, Ohio, and South Dakota.

States using less than 50 percent of their prime farmland for crops are Alabama, Connecticut, Florida, Georgia, Maine, Massachusetts, New Jersey, North Carolina, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, and Wyoming. The extensive holdings of important forest industries are probably responsible for the low percentage of prime farmland used as cropland in these states. It is important to recognize that prime farmland can be, and in many places is, some of the most productive land for timber and grazing. In a number of the southern and eastern states, the state tax structure and local customs promote the use of the land for growing trees for pulp, lumber, and naval stores. In the northeastern states, small tracts of prime farmland near population centers are held by speculators anticipating urban or industrial development.

Prime farmland accounts for a large share of the cropland in the major farming regions of the United States. The Corn Belt, for example, has 22 percent of the cropland in the country, 74 percent of which is prime farmland. By contrast, the Mountain Region in the western part of the United States has 10 percent of the Nation's cropland, only 21 percent of which is prime farmland (USDA, 1977).

In addition to making up a majority of the cropland in the country, prime farmland is more productive than nonprime farmland. For example, in Black Hawk County, Iowa, the soils in 44 of the 79 soil survey units qualify as prime farmland. These soils are the best suited to producing the two major crops in Iowa--corn and soybeans. The average yield of corn on these soils is 106 bushels per acre, and the average yield of soybeans is 40 bushels per acre (USDA, 1978a). The soils in another 31 of the soil survey units in Black Hawk County do not qualify as prime farmland but are also suited to corn and soybeans. However, the average yield of corn on these soils is only 66 bushels per acre, and the average yield of soybeans is only 25 bushels per acre.

Prime farmland produces the largest share of the Nation's total crop production and a large portion of the commodities that are exported. This land significantly helps to reduce the foreign trade deficit. In addition, the use of prime farmland for crops helps to ensure that efficient food, fiber, forage, and oilseed production will continue with the least damage to the environment. The loss of prime farmland to other uses puts more pressure on marginal lands, which generally are more erodible, droughty, and difficult to cultivate, and usually less productive.

Potential for Converting Land in Other Uses to Cropland

In 1977, there were nearly 1 billion acres of nonfederal land not used for cropland in the United States. Of this total, only 135 million acres have high or medium potential for use as cropland (USDA, 1979). See tables 4-1 and 4-2. Most of this acreage is pasture and rangeland. The rest is forest land or land in other uses.

Forty million acres of this total have high potential for use as cropland. This land can be converted to cropland through tillage and the use of basic conservation practices to control wind and water erosion. Of this 40 million acres, just over one-half is prime farmland. Most of this prime farmland is pastureland, native pasture, and rangeland that can be easily converted to cropland without special treatment. The rest of the land that has high potential for use as cropland has one or more soil limitations that must be considered before conversion to cropland.

Nearly 95 million acres have medium potential for use as cropland, about one-third (30 million acres) of which is prime farmland. Most of this prime farmland is pastureland, native pasture, and rangeland and has one or more soil limitations that must be considered before conversion to cropland. The rest of the land that has medium potential for use as cropland would require significant investment for conversion to cropland.

About 848 million acres of the nonfederal land not used for cropland have little or no potential for use as cropland. Some of this acreage is in small or isolated tracts, is committed to noncropland use, has a severe erosion hazard, or supports high-density forest. About 20 percent of this land is of high quality; however, the problems in converting it to cropland make conversion unlikely.

Considering only land having high and medium potential for conversion, the Potential Cropland Study of 1975 (USDA, 1977) showed fewer total acres of land having potential for use as cropland than was shown in the 1977 National Resource Inventories. Of the 111 million acres shown in 1975, 78 million acres had high potential and 33 million acres had medium potential. The different economic assumptions used in compiling the two studies explain the differences in results.

The Potential Cropland Study of 1975 used 1974 commodity prices, development costs, and production costs in evaluating the potential for conversion of noncropland areas to cropland. The 1977 National Resource Inventories (USDA, 1978b) used 1976 commodity prices, development costs, and production costs to evaluate the potential for conversion.

The potential for converting noncropland to cropland is highest in the Corn Belt, the Southern Plains, and the Northern Plains regions. The potential is lowest in the Caribbean area and in the Northeast and Pacific States (tables 4-1 and 4-2).

About 92 million acres of the 135 million acres of land that have high or medium potential for use as cropland are pastureland, native pasture, and rangeland; about 32 million acres are forest land; and the rest are in other uses (tables 4-3, 4-4, 4-5, and 4-6). This land is among the most productive in the country.

Table 4-1.--Potential for converting land in other uses to cropland, by farm production regions

Region	High potential	Medium potential	Low or zero potential
	Million acres	Million acres	Million acres
Northeast	1.2	4.5	71.7
Lake States	2.5	6.8	50.6
Corn Belt	5.6	9.9	40.3
Northern Plains	5.4	12.9	69.0
Appalachian	5.1	10.1	69.2
Southeast	5.3	11.8	69.2
Delta States	3.4	7.2	48.8
Southern Plains	5.5	14.9	134.8
Mountain	4.0	11.8	214.6
Pacific	1.9	4.7	75.0
Caribbean, Hawaii	.1	.2	4.4
Total	40.0	94.8	847.6

If all 135 million acres of this land were converted to cropland, there would be trade-offs. The forage produced on the 92 million acres of pastureland, native pasture, and rangeland would be lost; so would the wood crops produced on the 32 million acres of forest land. If it is assumed that the yields of forage and wood products on this land are average, this loss would be substantial. For example, if each acre of pastureland, native pasture, and rangeland in the high and medium potential categories is now producing 0.8 animal-unit-months per year, then the total loss each year would be 73.8 million animal-unit-months. This grazing capability of 73.8 million animal-unit-months would no longer be available for the production of red meat. These estimates are conservative because much of the land with high and medium potential for use as cropland is producing above-average yields of forage.

Most of the 32 million acres of forest land that has high and medium potential for use as cropland is east of the 100th meridian. Nearly half of this acreage is prime farmland that generally produces above-average yields of wood crops (table 4-7). If it is assumed that the average yield on this prime forest land is 85 cubic feet per acre per year, the loss in wood crop production would amount to 2.8 billion cubic feet per year. This fiber capability would no longer be available to lumber and wood products industries.

Nevertheless, despite these losses of forage and wood crops, conversion of the 135 million acres of land having high or medium potential for use as cropland could significantly increase the Nation's grain production and food exports.

Table 4-2.--Potential of pastureland, rangeland, forest, and other land for use as cropland, by state

State	High 1/ potential	Medium 2/ potential	Low 3/ potential	Zero potential	Total
	(1,000 acres)				
Alabama	1,110	3,087	7,573	12,720	24,490
Arizona	589	402	5,500	31,831	38,322
Arkansas	749	2,622	10,238	6,776	20,385
California	953	2,557	7,026	27,820	38,356
Colorado	377	2,438	8,588	18,738	30,141
Connecticut	43	100	324	1,375	1,842
Delaware	29	91	181	190	491
Florida	1,312	3,239	12,434	6,423	23,408
Georgia	2,278	3,666	8,812	11,003	25,759
Hawaii	43	78	1,107	2,085	3,313
Idaho	583	971	1,942	8,985	12,481
Illinois	649	1,418	2,583	2,926	7,576
Indiana	961	1,055	2,215	2,541	6,772
Iowa	768	1,428	2,389	2,495	7,080
Kansas	1,973	3,850	5,977	8,983	20,783
Kentucky	1,378	1,796	3,265	10,619	17,058
Louisiana	1,191	1,920	6,495	10,342	19,948
Maine	51	296	9,137	8,538	18,022
Maryland	168	389	1,117	1,437	3,111
Massachusetts	39	155	861	2,246	3,301
Michigan	592	1,466	6,314	11,101	19,473
Minnesota	1,246	3,164	9,208	8,067	21,685
Mississippi	1,453	2,639	5,598	9,354	19,044
Missouri	2,522	4,694	7,485	9,919	24,620
Montana	1,428	4,326	11,710	31,770	49,234
Nebraska	1,259	2,758	7,927	14,163	26,107
Nevada	58	451	2,635	6,026	9,170
New Hampshire	34	208	2,028	2,030	4,300
New Jersey	119	348	755	1,390	2,612
New Mexico	537	860	13,379	33,141	47,917
New York	380	1,450	5,078	13,625	20,533
North Carolina	1,478	3,882	6,215	8,383	19,958
North Dakota	1,025	1,945	5,240	5,797	14,007
Ohio	659	1,341	3,632	4,092	9,724
Oklahoma	1,802	4,171	7,714	15,171	28,858
Oregon	370	887	3,507	18,001	22,765
Pennsylvania	286	1,274	4,639	12,079	18,278
Rhode Island	6	16	59	284	365
South Carolina	638	1,796	6,573	3,697	12,704
South Dakota	1,180	4,370	7,897	12,973	26,420
Tennessee	1,627	2,407	3,925	9,859	17,818
Texas	3,715	10,749	49,809	62,158	126,431
Utah	82	523	1,544	11,847	13,996

Table 4-2.--Potential of pastureland, rangeland, forest, and other land for use as cropland by state--Continued

State	High 1/ potential	Medium 2/ potential	Low 3/ potential	Zero potential	Total
	(1,000 acres)				
Vermont--------------	56	192	976	3,405	4,629
Virginia-------------	580	1,638	6,165	8,985	17,368
Washington-----------	546	1,267	4,955	13,660	20,428
West Virginia--------	73	390	1,325	10,461	12,249
Wisconsin------------	707	2,217	8,086	7,819	18,829
Wyoming--------------	297	1,778	7,013	19,949	29,037
Caribbean------------	83	152	102	1,108	1,445
Total-----------	40,082	94,917	299,257	548,387	982,643

1/ High potential includes 956,000 acres of class VII and VIII land shown as zero acres in tables 4-3 through 4-6.

2/ Medium potential includes 2.8 million acres of class VII and VIII land shown as zero acres in tables 4-3 through 4-6.

3/ Low potential includes 26.4 million acres of class VII and VIII land included in zero potential in tables 4-3 through 4-6.

Source: 1977 National Resource Inventories (USDA, 1978b). Preliminary estimates April 1979 (Subject to revision)

Table 4-3.--Potential of forest land for use as cropland 1/

Class and subclass	High potential	Medium potential	Low potential	Zero potential	Total
			(1,000 acres)		
I-------------------	427	381	789	335	1,932
IIe-----------------	2,118	4,047	11,556	4,396	22,117
IIw-----------------	1,597	3,206	8,009	2,664	15,476
IIs-----------------	355	756	1,419	565	3,095
IIc-----------------	83	163	351	103	700
IIIe----------------	702	4,532	15,552	7,860	28,646
IIIw----------------	1,397	3,696	11,640	5,153	21,886
IIIs----------------	139	1,073	4,373	1,926	7,511
IIIc----------------	0	16	14	51	81
IVe-----------------	196	1,895	12,380	11,998	26,469
IVw-----------------	287	1,600	10,673	8,520	21,080
IVs-----------------	179	1,014	6,122	4,615	11,930
IVc-----------------	0	9	112	93	214
V-------------------	85	978	6,303	9,272	16,638
VIe-----------------	46	686	7,679	36,861	45,272
VIw-----------------	26	257	1,953	3,770	6,006
VIs-----------------	49	482	13,499	17,721	31,751
VIc-----------------	0	0	22	206	228
VII & VIII----------	0	0	0	108,636	108,636
Total---------	7,686	24,791	112,446	224,745	369,668

1/ 1977 National Resource Inventories (USDA, 1978b). Preliminary estimates April 1979 (Subject to revision)

Table 4-4.--Potential of pastureland and native pasture for use as cropland 1/

Class and subclass	High potential	Medium potential	Low potential	Zero potential	Total
	(1,000 acres)				
I-------------------	1,380	754	676	121	2,931
IIe-----------------	6,203	6,637	5,225	749	18,814
IIw-----------------	2,974	2,708	3,087	720	9,489
IIs-----------------	775	928	651	124	2,478
IIc-----------------	424	245	265	6	940
IIIe----------------	3,645	9,871	11,231	1,897	26,644
IIIw----------------	1,527	2,923	3,318	595	8,363
IIIs----------------	533	1,106	2,079	246	3,964
IIIc----------------	15	120	47	28	210
IVe-----------------	802	4,025	9,685	2,897	17,409
IVw-----------------	431	1,592	2,516	732	5,271
IVs-----------------	260	792	1,824	640	3,516
IVc-----------------	9	66	48	19	142
V-------------------	155	270	949	2,980	4,354
VIe-----------------	99	1,133	3,727	8,333	13,292
VIw-----------------	40	160	267	406	873
VIs-----------------	131	403	1,153	1,640	3,327
VIc-----------------	0	15	85	20	120
VII & VIII----------	0	0	0	11,427	11,427
Total-----------	19,403	33,748	46,833	33,580	133,564

1/ 1977 National Resource Inventories (USDA, 1978b). Preliminary estimates April 1979 (Subject to revision)

Table 4-5.--Potential of rangeland for use as cropland 1/

Class and subclass	High potential	Medium potential	Low potential	Zero potential	Total
	(1,000 acres)				
I	236	140	233	138	747
IIe	1,713	2,695	4,525	802	9,735
IIw	284	575	1,145	165	2,169
IIs	516	400	495	12	1,423
IIc	635	962	1,264	366	3,227
IIIe	3,280	10,249	20,147	4,520	38,196
IIIw	221	992	1,958	464	3,635
IIIs	193	868	1,705	400	3,166
IIIc	405	1,023	1,320	304	3,052
IVe	780	5,282	23,185	9,923	39,170
IVw	132	599	1,875	690	3,296
IVs	99	722	2,773	1,202	4,796
IVc	61	185	2,069	214	2,529
V	58	191	572	3,144	3,965
VIe	498	3,405	25,250	77,662	106,815
VIw	46	154	1,261	3,011	4,472
VIs	284	807	6,350	24,257	31,698
VIc	286	113	2,080	1,442	3,921
VII & VIII	0	0	0	141,802	141,802
Total	9,727	29,362	98,207	270,518	407,814

1/ 1977 National Resource Inventories (USDA, 1978b). Preliminary estimates April 1979 (Subject to revision)

Table 4-6.--Potential of other land for use as cropland 1/

Class and subclass	High potential	Medium potential	Low potential	Zero potential	Total
	(1,000 acres)				
I--------------------	145	131	425	469	1,170
IIe------------------	511	540	2,667	1,526	5,244
IIw------------------	505	650	1,129	1,187	3,471
IIs------------------	80	131	337	243	791
IIc------------------	50	73	195	151	469
IIIe-----------------	259	498	2,240	1,593	4,590
IIIw-----------------	307	717	1,808	1,677	4,509
IIIs-----------------	44	125	913	482	1,564
IIIc-----------------	18	32	35	62	147
IVe------------------	113	314	1,218	1,205	2,850
IVw------------------	110	503	2,041	2,218	4,872
IVs------------------	31	135	418	676	1,260
IVc------------------	0	2	6	14	22
V--------------------	52	58	507	1,367	1,984
VIe------------------	65	158	615	2,133	2,971
VIw------------------	7	62	264	872	1,205
VIs------------------	4	88	466	1,067	1,625
VIc------------------	9	16	63	9	97
VII & VIII-----------	0	0	0	32,865	32,865
Total----------	2,310	4,233	15,347	49,816	71,706

1/ 1977 National Resource Inventories (USDA, 1978b). Preliminary estimates April 1979 (Subject to revision)

Table 4-7.--Nonfederal forest land in 1977 that is classified as prime farmland that has high or medium potential for use as cropland, by state 1/

State	Prime farmland	High potential	Medium potential
	(1,000 acres)		
Alabama	2,796	235	772
Alaska 1/	----	----	----
Arizona	0	0	0
Arkansas	4,222	320	521
California	56	0	11
Colorado	0	0	0
Connecticut	114	0	26
Delaware	48	8	11
Florida	746	124	78
Georgia	2,742	668	734
Hawaii	8	2	2
Idaho	5	4	0
Illinois	602	28	190
Indiana	1,093	269	199
Iowa	287	21	60
Kansas	317	28	56
Kentucky	798	215	184
Louisiana	2,430	381	398
Maine	353	2	27
Maryland	225	23	44
Massachusetts	201	6	42
Michigan	1,773	109	270
Minnesota	2,508	280	687
Mississippi	3,027	522	622
Missouri	1,144	114	285
Montana	3	0	0
Nebraska	71	7	15
Nevada	0	0	0
New Hampshire	37	3	13
New Jersey	513	36	70
New Mexico	0	0	0
New York	824	28	106
North Carolina	2,120	331	797
North Dakota	84	7	0
Ohio	837	110	219
Oklahoma	391	32	110
Oregon	172	21	56
Pennsylvania	1,535	25	164
Rhode Island	40	2	4
South Carolina	1,397	90	216
South Dakota	0	0	0
Tennessee	1,454	387	359
Texas	2,277	23	221

Table 4-7.--Nonfederal forest land in 1977 that is classified as prime farmland that has high or medium potential for use as cropland, by state 1/--Continued

State	Prime farmland	High potential	Medium potential
		(1,000 acres)	
Utah	0	0	0
Vermont	140	3	8
Virginia	2,176	226	425
Washington	167	51	15
West Virginia	88	5	17
Wisconsin	2,544	153	505
Wyoming	0	0	0
Caribbean	5	4	0
Total	42,370	4,903	8,539

1/ No data available for Alaska.
Source: 1977 National Resource Inventories (USDA, 1978b)

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Chapter 5 - Water Resources

Section A-Supply

Water continuously evaporates from the oceans and other water surfaces into the atmosphere. About 40,000 billion gallons per day (bgd) pass over the contiguous United States in the form of water vapor. Evaporation from the Gulf of Mexico and the Atlantic and Pacific Oceans provides more than 90 percent of this water vapor. The source of the rest is inland evaporation and transpiration. See figure 5A-1. (USWRC, 1978e).

Each year an average of about 30 inches (4,200 bgd) of water precipitates to the surface of the contiguous United States. About 26 inches is rainfall. The rest is snow, sleet, or hail. Average annual precipitation ranges from less than 4 inches in parts of the Great Basin and Lower Colorado Regions to more than 200 inches in the coastal area of the Pacific Northwest. Figure 5A-2 shows average annual precipitation by region and figure 5A-3 shows mean annual precipitation by state. Mean annual precipitation is not shown for Hawaii, Puerto Rico, Alaska, and the Virgin Islands because of their extreme ranges of precipitation. (USWRC, 1978d).

Rainwater soaks into the soil, runs off downslope, or accumulates on the surface. Of the average annual precipitation of 30 inches (4,200 bgd), about 21 inches (2,900 bgd) returns to the atmosphere through transpiration by plants, evaporation from water and wet surfaces, or by absorption of vapors. The remaining 9 inches (1,300 bgd) either soaks down to the ground water table or runs into surface supplies and then moves to the ocean as subsurface flow or streamflows. Figure 5A-4 shows the average annual runoff in the United States.

Ground Water

About 3 inches of the precipitation that soaks into the ground passes beyond the soil moisture zone and recharges ground water supplies. Ground water is withdrawn by pumping, emerges as streamflow from natural springs or other seeping sources, or reenters the ocean as subsurface flow. During years of subnormal precipitation, the flows of smaller streams usually come from ground-water storage sources. A numerical assessment of these flows would be meaningless because of the degree of interaction between surface and ground-water sources.

Table 5A-1 shows the Nation's supply of ground water, compares the amount of fresh ground water in storage with current withdrawals, and shows the relationship between withdrawals and recharge. More than 40 percent of the water used in 14 of the 106 water resources subregions came from the ground. For example, 48 percent of the total fresh water used in California in 1975 was obtained from wells. Ground water accounted for 24 percent of the fresh water used in the Nation.

A considerable amount of ground water is not considered renewable because it has accumulated over geologic time. In some areas, the quantity extracted exceeds the recharge rate. Withdrawal in excess of recharge is

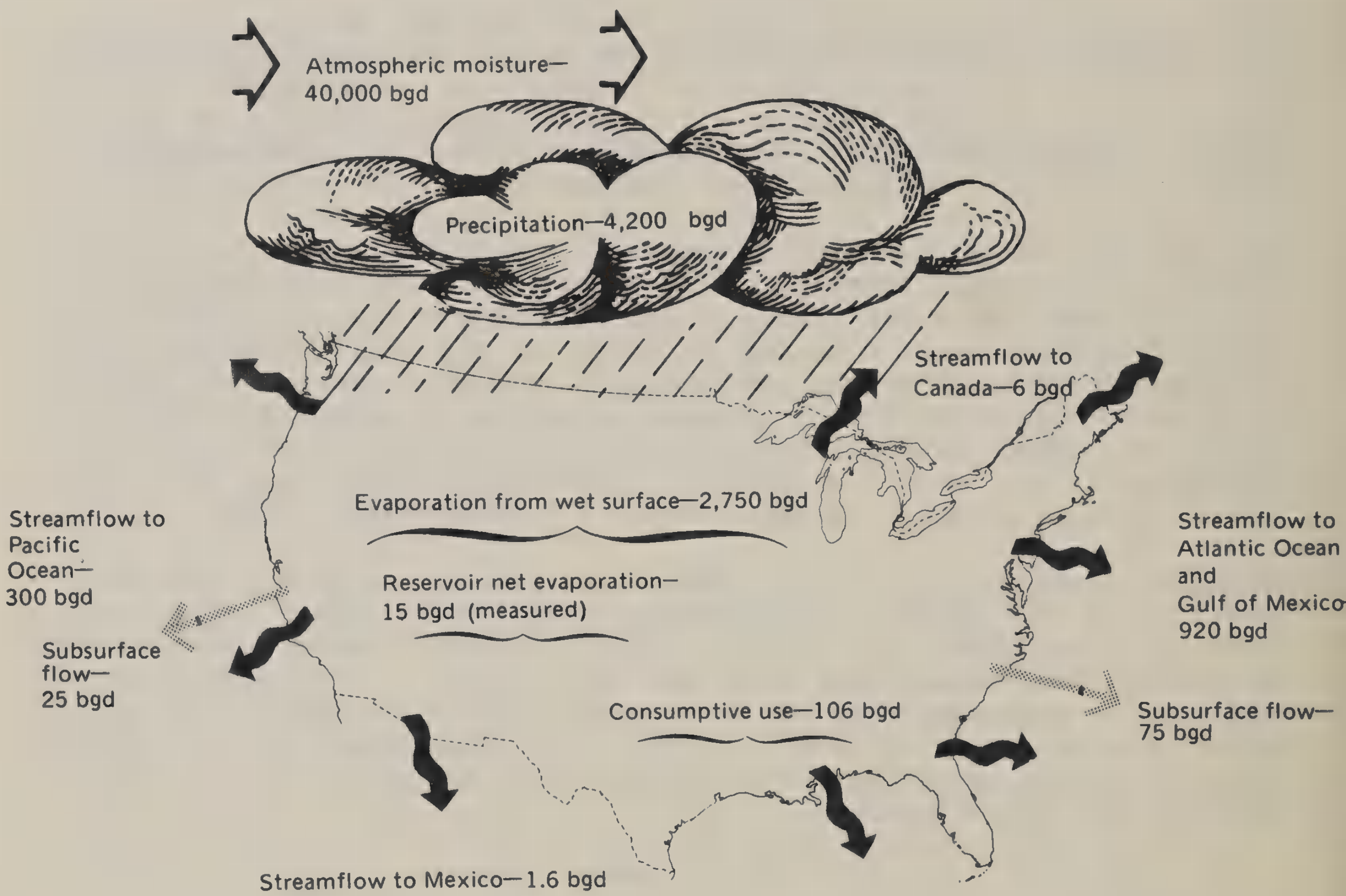


Figure 5A-1.--Water budget for the conterminous United States. (U.S. Water Resources Council, 1978e)

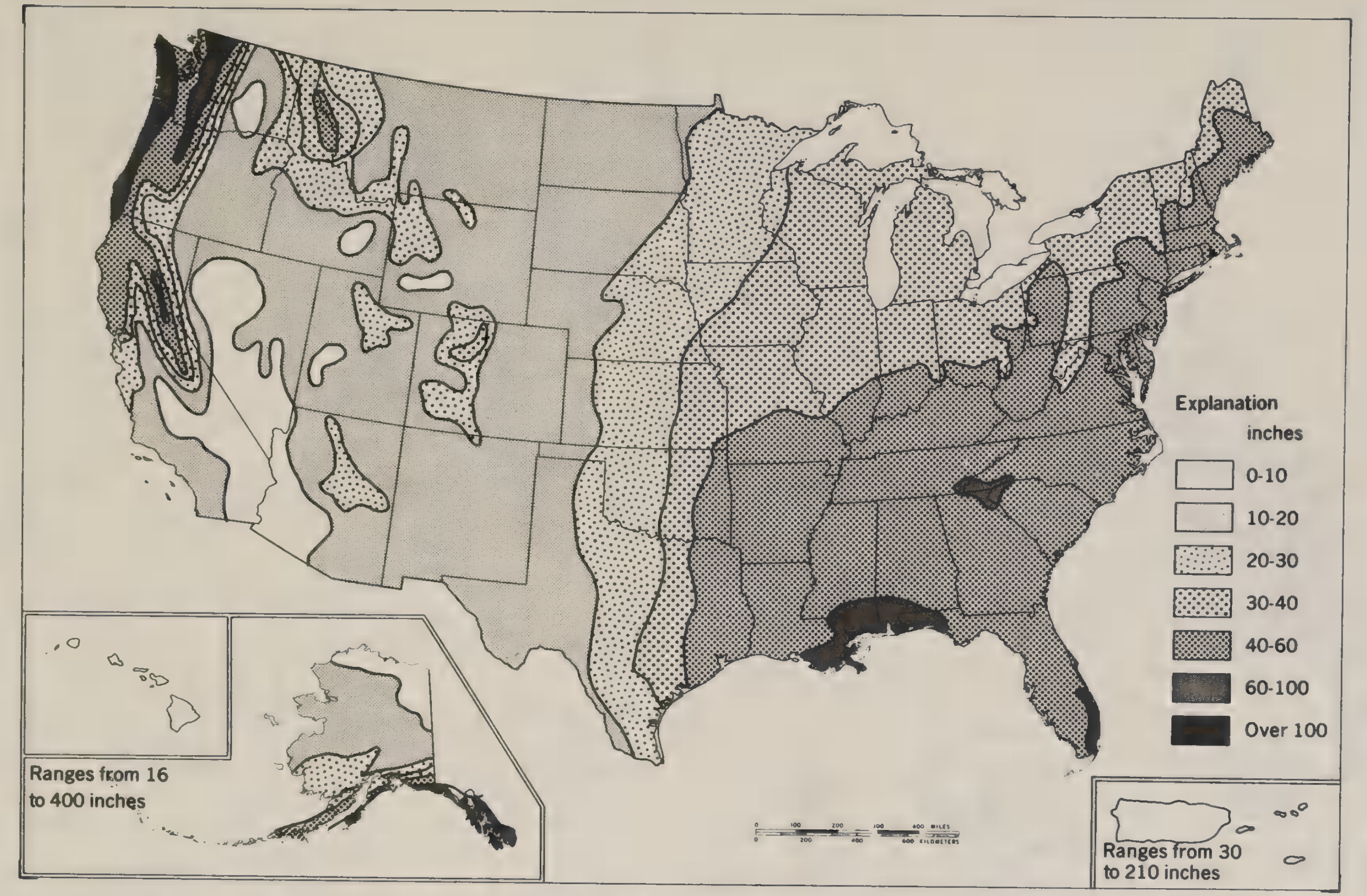


Figure 5A-2.--Average annual precipitation. (U.S. Water Resources Council, 1978e)

Figure 5A-3.--Mean annual precipitation in the conterminous United States. (Department of Commerce, U.S. Weather Bureau)

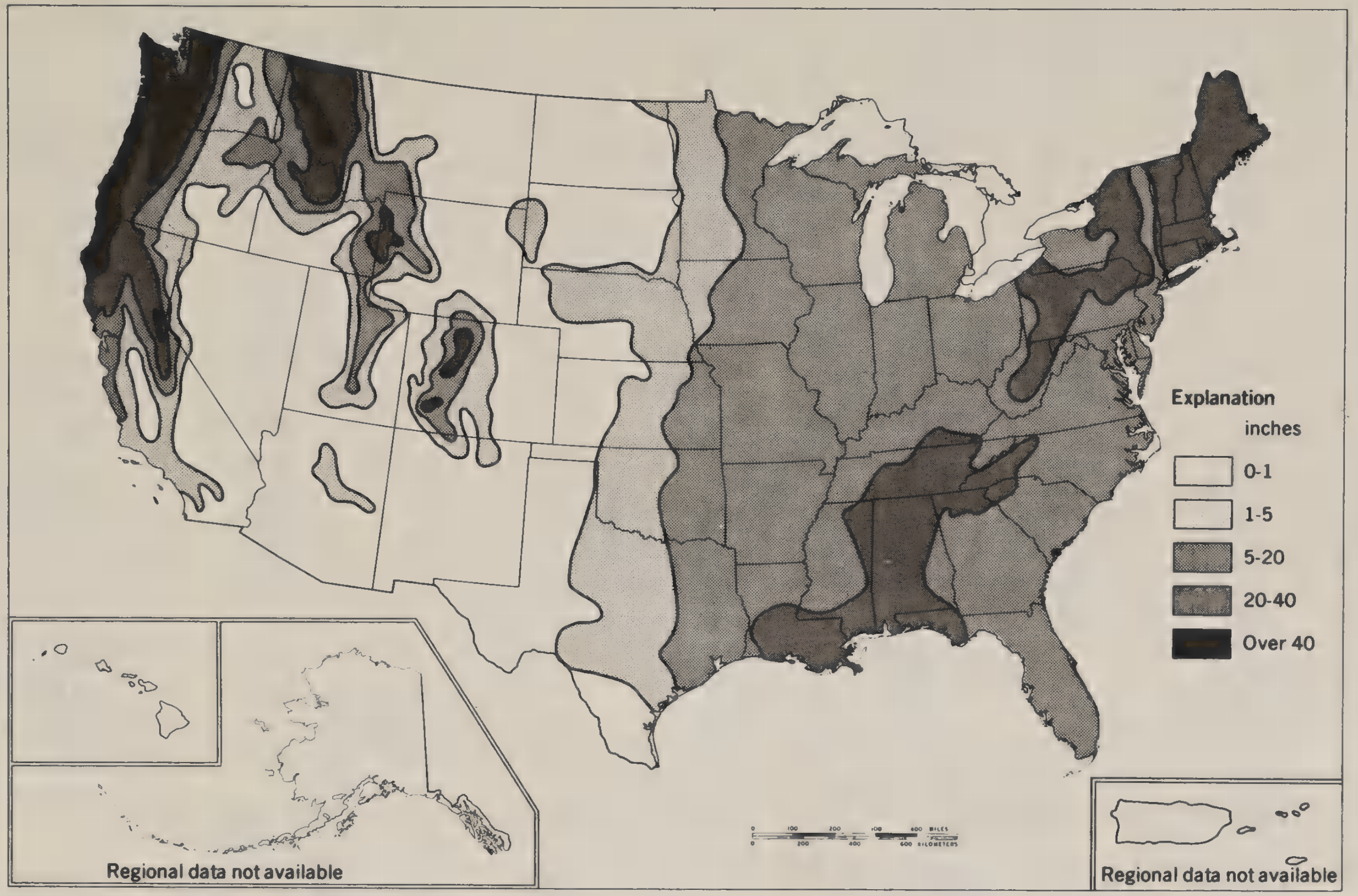


Figure 5A-4.--Average annual runoff. (U.S. Water Resources Council, 1978e)

Table 5A-1.--The Nation's fresh ground water supplies

Water resources regions	Ground-water in storage that can feasibly be withdrawn 1/	Ground-water withdrawals: Portion of total withdrawals from ground water	Ground-water withdrawals: Total ground-water withdrawals	Withdrawals in excess of recharge: Amount mined	Withdrawals in excess of recharge: % of ground-water mined	Withdrawals in excess of recharge: Water resource subregions: In region	Withdrawals in excess of recharge: Water resource subregions: With mining
	Trillion gallons	Percent	mgd	mgd	percent	number	number
New England---------	N/A 2/	12	635	0	0	6	0
Mid-Atlantic--------	350	15	2,661	32	1	6	3
South Atlantic-Gulf-	1,120	22	5,449	339	6	9	8
Great Lakes---------	260	3	1,215	27	2	8	1
Ohio----------------	110	5	1,843	0	0	7	0
Tennessee-----------	530	4	271	0	0	2	0
Upper Mississippi---	215	19	2,366	0	0	5	0
Lower Mississippi---	1,270	33	4,838	412	9	3	3
Souris-Red-Rainy----	110	26	86	0	0	1	0
Missouri------------	450	27	10,407	2,557	25	11	10
Arkansas-White-Red--	500	69	8,846	5,457	62	7	7
Texas-Gulf----------	650	43	7,222	5,578	77	5	5
Rio Grande----------	1,260	37	2,335	657	28	5	4
Upper Colorado------	35	2	126	0	0	3	0
Lower Colorado------	N/A	56	5,008	2,415	48	3	3
Great Basin---------	100	18	1,424	591	42	4	4
Pacific Northwest---	180	20	7,348	627	9	7	6
California----------	55	48	19,160	2,197	12	7	5
Conterminous U.S.---	N/A	24	81,240	20,889	26	99	59
Alaska--------------	1,120	14	44	0	0	1	0
Hawaii--------------	N/A	42	790	0	0	4	0
Caribbean-----------	16	28	254	13	5	2	1
Total U.S.-----	N/A	24	82,328	20,902	25	106	60

1/ Depth, quality, and ease of extraction are not nationally consistent.
2/ N/A means data not available. Sources: Geological Survey Professional Paper 813 Series (USDI, 1974-79). Second National Water Assessment (U.S. Water Resources Council, 1978e).

considered ground water mining. Ground water mining is depleting the Nation's supplies at a rate of 21 bgd. The most serious depletion of ground water is in the High Plains areas extending from Texas to Nebraska. Central Arizona and parts of California also depend heavily on ground water. In central Arizona, the ground water levels are falling 7 to 10 feet per year. Figure 5A-5 shows areas where ground water mining occurs.

Surface Water

Surface water is the water flowing in streams or held in surface storage. Rivers, streams, lakes, swamps, marshes, and manmade reservoirs contain surface water. Table 5A-2 shows the total area of surface water by state.

Surface water is stored naturally in lakes and wetlands or artificially in reservoirs. There are about 49,000 large reservoirs and more than two million small reservoirs in the United States. About 1,600 of the large reservoirs can store more than 5,000 acre-feet of water. Thirty-one of these have a combined storage capacity of about 2 million acre-feet and account for 41 percent of the Nation's total storage capacity (USWRC, 1978d). Table 5A-3 shows the storage capacity of reservoirs by water resources regions. In semiarid and arid areas, pan evaporation exceeds precipitation. See figure 5A-6. Net evaporation from reservoirs in mgd and its equivalent as a percentage of streamflow are shown in table 5A-3.

The United States has greatly varied geographic and climatic conditions that cause continuously changing precipitation patterns. The least precipitation usually occurs in fall and early winter, and the most in spring. However, seasonal variation in precipitation is very small in the northeast. In the mid-continent area, summer storms in the May-October period produce more than twice the precipitation that occurs during the rest of the year. Thunderstorms provide inland areas with precipitation in summer, hurricanes provide rain in coastal areas in the fall, and cyclonic storms occur in winter in the southeast. In high western mountain areas, winter is the period of heaviest precipitation, but this precipitation occurs as snow. In the southwest, up to 75 percent of the annual runoff occurs during a period of a few weeks in the spring when snow melts. During the summer months, much of California has virtually no precipitation. Coastal Alaska receives precipitation mainly late in fall, while the interior receives precipitation mainly in summer. In both Hawaii and the Caribbean, fall is the wet season and early spring the dry. See figure 5A-7.

Precipitation and the resulting runoff and streamflow vary widely from region to region and from year to year. See figures 5A-8 and 5A-9 and table 5A-4. The runoff and streamflow in the New England Region tend to vary less from year to year than most of the other regions. In contrast, the runoff in the southwestern regions varies widely from year to year. Runoff in the other regions ranges between these two extremes.

There is a great contrast in the quantity of water flowing out of the water resources regions during an average year compared with that in a very wet year and a dry or very dry year. Table 5A-4 shows the annual streamflow volume divided by 365 to show streamflow in bgd's. For example, the annual streamflow of some regions varies from less than 30 to over 200 percent of the annual mean streamflow.

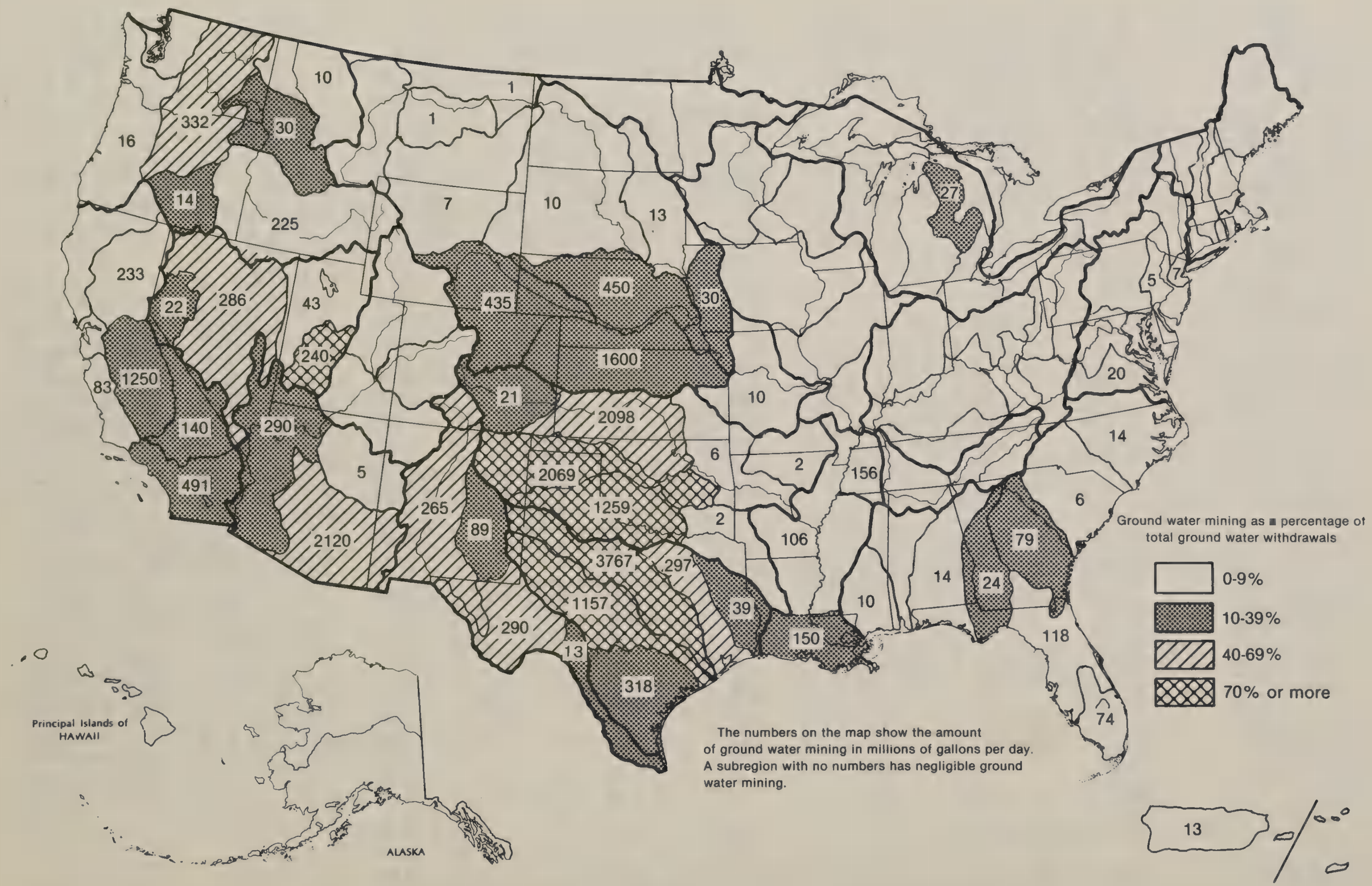


Figure 5A-5.--Areas of ground water mining, "1975." (U.S. Water Resources Council, 1978b)

Table 5A-2.--Water surface areas by state, 1977

State	Great Lakes, coastal waters, bays, & estuaries	Inland water: Total inland	Inland water: Large bodies: Rivers 1/8 mile wide water over 40 acres	Inland water: Small water bodies: Streams less than 1/8 mile	Inland water: Small water bodies: 2-40 acres	Inland water: Small water bodies: less than 2 acres
	----1,000 acres----					
Alabama--------	358	825	597	123	78	27
Arizona--------	---	325	314	7	1	3
Arkansas-------	---	943	686	131	79	47
California-----	44	1,728	1,489	165	63	11
Colorado-------	---	447	311	73	54	9
Connecticut----	367	132	93	12	22	5
Delaware-------	224	86	72	8	5	1
Florida--------	1,110	3,502	3,006	184	293	19
Georgia--------	31	917	521	135	229	32
Idaho----------	---	804	737	54	10	3
Illinois-------	977	698	435	157	64	42
Indiana--------	146	297	135	89	49	24
Iowa-----------	---	419	198	173	19	29
Kansas---------	---	588	295	134	93	66
Kentucky-------	---	608	454	85	31	38
Louisiana------	650	2,667	2,309	230	107	21
Maine----------	705	1,524	1,415	60	45	4
Maryland-------	1,105	490	439	33	13	5
Massachusetts--	614	284	233	16	29	6
Michigan-------	24,688	1,105	894	87	106	18
Minnesota------	1,416	3,512	3,106	154	231	21
Mississippi----	356	725	313	178	177	57
Missouri-------	---	844	473	162	93	116
Montana--------	---	1,289	1,040	134	97	18
Nebraska-------	---	623	451	88	57	27
Nevada---------	---	447	428	16	3	0
New Hampshire--	---	226	177	24	22	3
New Jersey-----	246	243	205	12	24	2
New Mexico-----	---	201	149	41	6	5
New York-------	2,801	1,393	1,136	148	90	19
North Carolina-	---	2,741	2,449	156	96	40
North Dakota---	---	1,304	923	90	273	18
Ohio-----------	2,212	374	173	117	59	25
Oklahoma-------	---	1,140	828	85	108	119
Oregon---------	31	715	606	87	17	5
Pennsylvania---	470	437	268	120	33	16
Rhode Island---	9	114	105	3	5	1

Table 5A-2.--Water surface areas by state, 1977--Continued

State	Great Lakes, coastal waters, bays, & estuaries	Inland water: Total inland	Large bodies: Rivers 1/8 mile wide water over 40 acres	Small water bodies: Streams less than 1/8 mile	Small water bodies: 2-40 acres	Small water bodies: less than 2 acres
	-----1,000 acres-----					
South Carolina-	88	748	569	99	66	14
South Dakota---	---	959	743	49	137	30
Tennessee------	---	785	633	82	35	35
Texas----------	5	4,000	3,315	276	223	186
Utah-----------	---	1,844	1,809	28	4	3
Vermont--------	---	247	219	19	6	3
Virginia-------	967	853	657	125	56	15
Washington-----	1,534	1,194	1,039	86	62	7
West Virginia--	---	148	71	57	13	7
Wisconsin------	6,440	1,341	1,095	112	122	12
Wyoming--------	---	622	525	51	40	6
Subtotal Conterminous U.S.----	47,593	47,458	38,138	4,555	3,545	1,220
Alaska---------	------	12,787	12,787	N/A	N/A	N/A
Hawaii---------	------	22	15	7	0	0
Caribbean------	------	14	2	8	4	0
Total U.S.-	47,593	60,281	50,942	4,570 1/	3,549 1/	1,220 1/

1/ Exclusive of small water bodies (less than 40 acres) and streams less than 1/8 mile wide in Alaska.

Sources: Statistical Abstract of the United States. (USDC, 1969).
1977 National Resource Inventories (USDA, 1978a).

Table 5A-3.--Reservoir storage and evaporation for the United States by Water Resources Regions

Water resources region	Storage capacity: Maximum storage 1/	Storage capacity: Existing storage 2/	Normal pool surface area	Net evaporation from reservoirs 3/: Estimated net evaporation	Net evaporation from reservoirs 3/: Net evaporation as a percentage of mean streamflow
	(Billion gallons)		(1,000 acres)	(mgd)	(Percent)
New England---------	6,310	4,722	412	0	----
Mid-Atlantic--------	7,853	6,271	142	0	----
South Atlantic-Gulf-	19,799	13,382	1,766	0	----
Great Lakes---------	4,199	3,292	182	0	----
Ohio----------------	14,098	5,161	681	0	----
Tennessee-----------	7,724	3,600	466	0	----
Upper Mississippi---	7,574	4,231	469	37	0.03
Lower Mississippi---	6,398	2,034	542	0	----
Souris-Red-Rainy----	2,429	1,430	18	11	0.18
Missouri------------	38,488	27,161	2,087	3,954	6.94
Arkansas-White-Red--	22,761	9,853	1,515	1,898	2.91
Texas-Gulf----------	17,912	7,660	930	1,289	3.79
Rio Grande----------	4,410	2,534	173	653	13.60
Upper Colorado------	3,691	3,328	318	688	5.55
Lower Colorado------	23,491	19,962	251	1,153	18.59
Great Basin---------	1,368	1,239	130	317	2.31
Pacific Northwest---	21,257	17,839	1,280	1,915	0.72
California----------	14,416	12,697	413	646	0.89
Subtotal Conterminous U.S.--------------	224,178	146,396	11,775	12,561	1.11
Alaska--------------	283	267	12	0	----
Hawaii--------------	17	13	1	1	0.01
Caribbean-----------	132	92	7	0	----
Total U.S.------	224,610	146,768	11,795	12,562	0.61

1/ Maximum storage is flood capacity over normal storage.
2/ Normal storage is that capacity designated for purposes other than flood control.
3/ Zero values indicate that evaporation losses are offset by precipitation.
Source: Second National Water Assessment (U.S. Water Resources Council, 1978d).

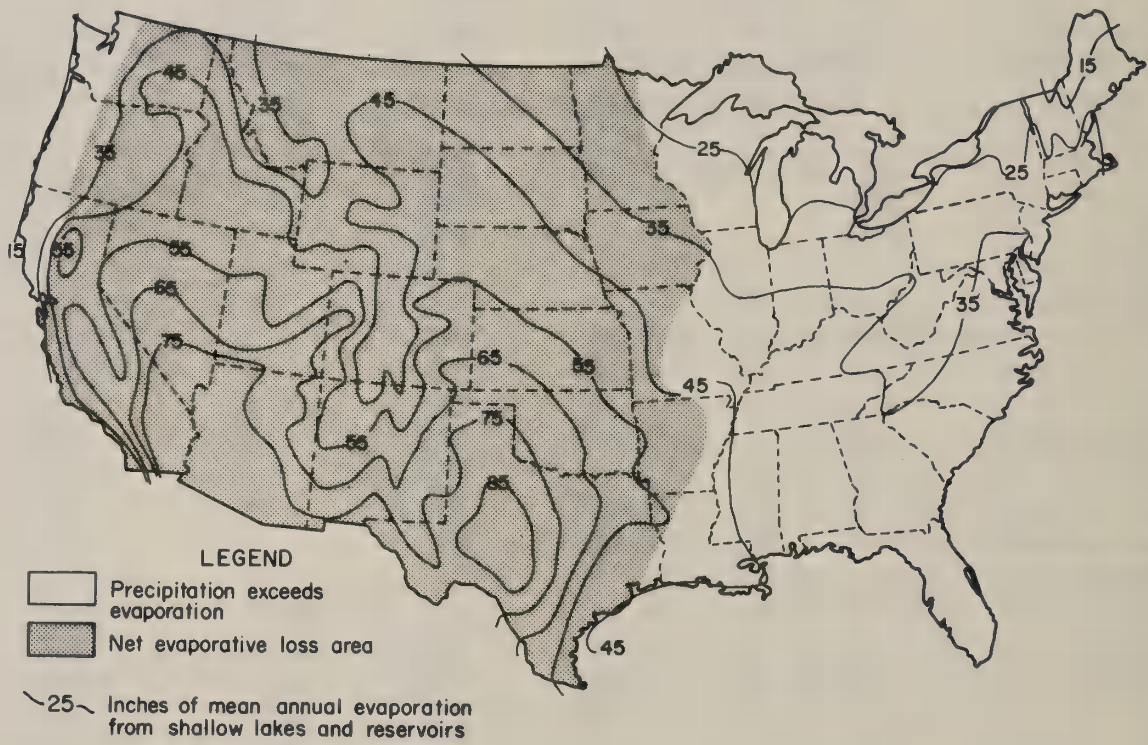


Figure 5A-6.--Evaporation and net evaporative loss areas.

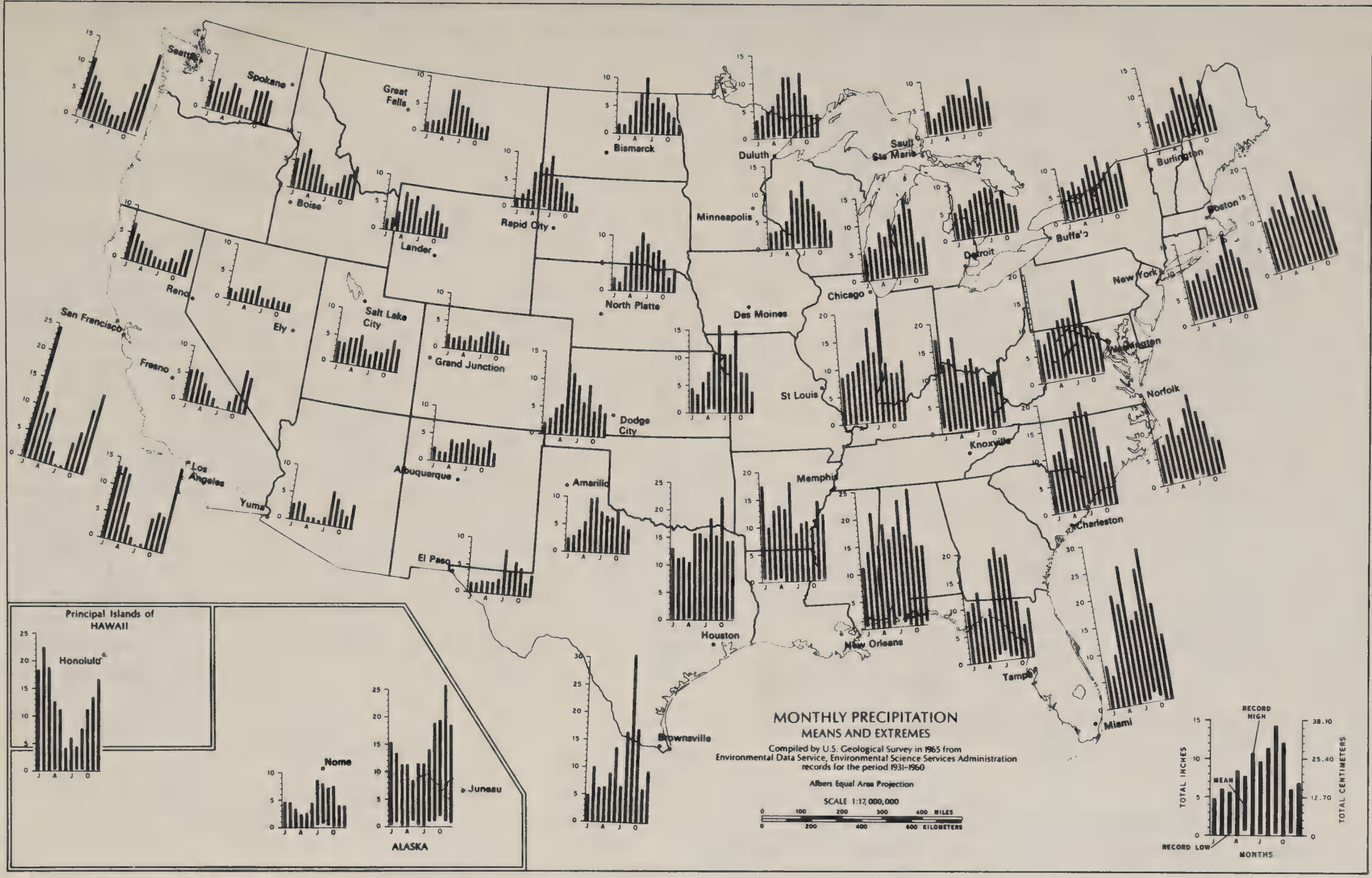


Figure 5A-7.--Monthly precipitation means and extremes.

Table 5A-4.--Streamflow frequency

Water resource regions and numbers	Mean year	Percentage chance that the streamflows will reach or exceeds the levels listed below			
		5%	50%	80%	95%
		(Streamflow in billion gallons per day)			
New England (1)	78.2	107.7	77.4	62.7	48.3
Mid-Atlantic (2)	79.2	115.1	77.8	61.2	48.4
South Atlantic-Gulf (3)	228.0	356.6	219.3	164.1	121.8
Great Lakes (4)	72.7	103.9	71.7	57.3	44.9
Ohio (5)	178.0	254.0	178.0	141.0	105.0
Tennessee (6)	40.8	57.9	40.8	35.9	31.4
Upper Mississippi (7)	121.0	189.0	121.0	91.8	65.3
Lower Mississippi (8)	433.0	757.0	433.0	282.0	202.0
Souris-Red-Rainy (9)	6.0	11.4	5.6	3.4	1.8
Missouri (10)	44.1	74.3	43.2	29.9	17.6
Arkansas-White-Red (11)	62.6	120.7	59.1	37.4	21.6
Texas-Gulf (12)	28.3	62.4	22.9	12.3	6.3
Rio Grande (13)	1.2	4.4	.6	.3	.2
Upper Colorado (14)	10.0	15.6	10.0	7.0	3.9
Lower Colorado (15)	1.6	1.7	1.6	1.4	1.2
Great Basin (16)	2.6	4.7	2.4	1.6	1.2
Pacific Northwest (17)	255.3	344.7	254.3	213.3	179.7
California (18)	47.4	87.4	44.3	29.8	19.5
Alaska (19)	905.0	1,030.0	898.0	795.0	705.0
Hawaii (20)	6.7	10.3	6.3	4.9	3.8
Caribbean (21)	4.9	7.1	4.5	3.3	1.6
Total, 1/	2,150.0	3,004.4	2,119.7	1,692.6	1,385.7

1/ Total excludes streamflow figures from the Ohio, Tennessee, Upper Mississippi, Missouri, Arkansas-White-Red, and Upper Colorado Regions because these are inflows to other regions.

Source: Second National Water Assessment (U.S. Water Resources Council, 1979).

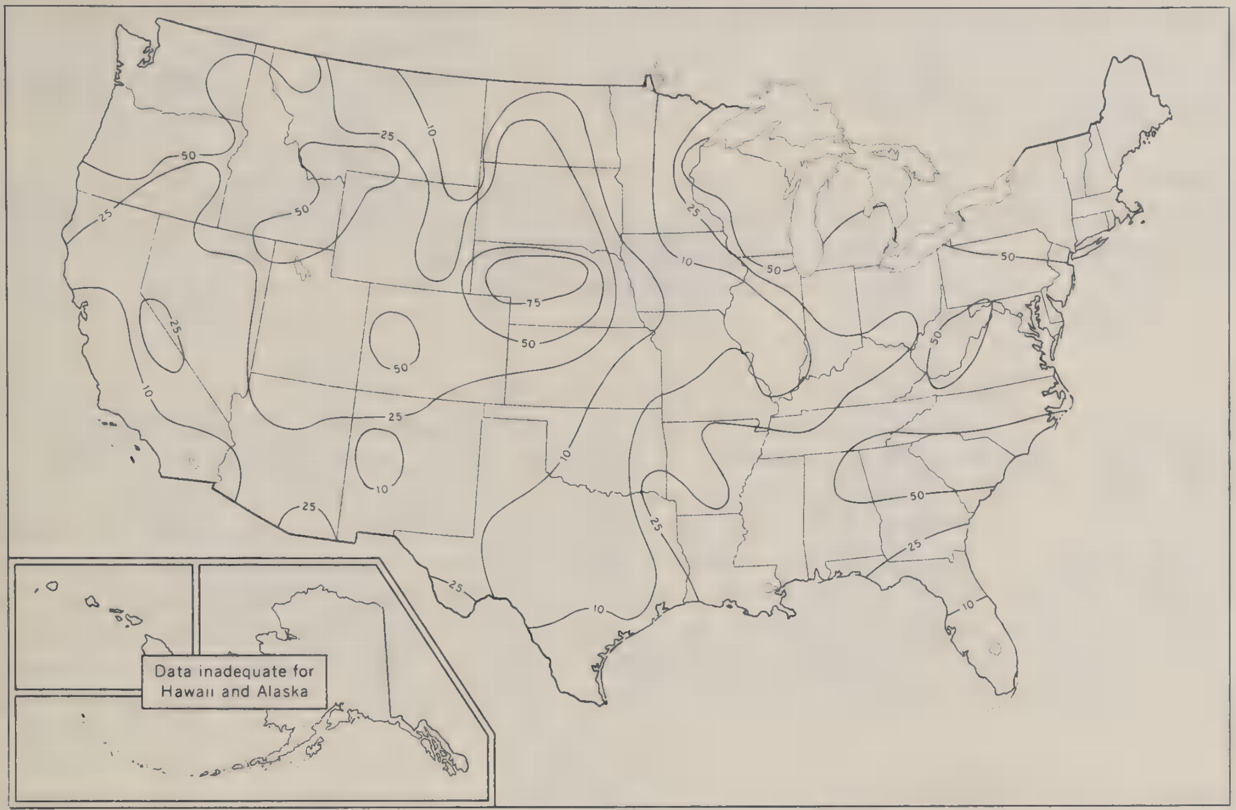


Figure 5A-8.--Minimum annual runoff. (Percentage of 1931-1960 average.)

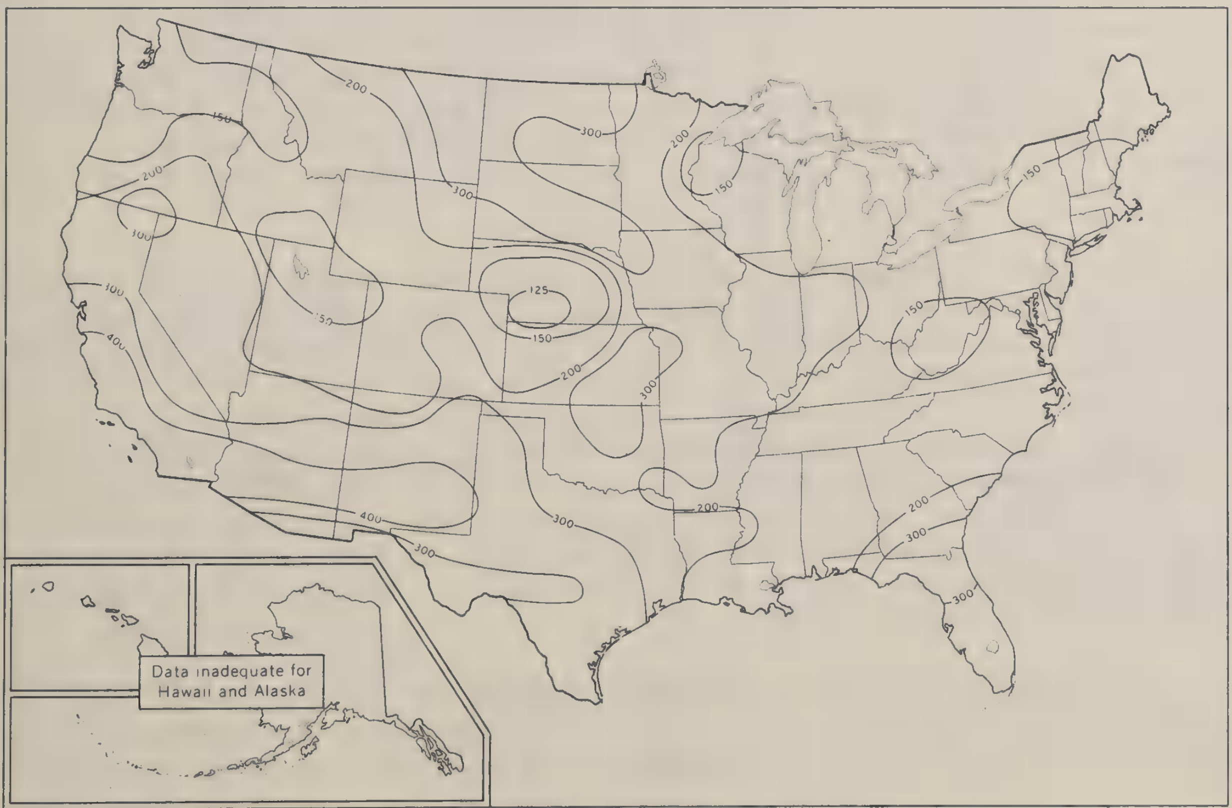


Figure 5A-9.--Maximum annual runoff. (Percentage of 1931-1960 average.)

Seasonal variations occur in runoff and streamflow. Figures 5A-10 and 5A-11 and table 5A-5 show variations in streamflow. These variations, particularly during the growing season, can significantly affect food and fiber production.

Because of the great variations in precipitation in the United States, types of vegetation have developed that vary greatly in their moisture requirements. They indicate different climatic types. See figure 5A-12. Different forms of agriculture are adapted to the moisture requirements of these climatic types.

There are few superhumid or rain forest climates in the United States. The eastern United States has an almost entirely humid climate and it was originally covered with forest. Together with southeastern Canada, it forms one of the largest humid regions in the world. This region has precipitation levels that in the long run exceed the rates of evapotranspiration. Compared to other parts of the country, it has high soil moisture, minimal moisture fluctuations, an abundance of surface water, and abundant vegetation. Droughts do occur, but they occur less frequently since drought is a relative phenomenon based on the demands made on available moisture. Droughts in this humid region are essentially short term and seasonal.

North-south belts of semihumid climate extend through the central United States. This central area was originally covered with tall grass. Semiarid climate dominates the western United States, except for narrow bands of more rainy climates paralleling the coast. This semiarid region includes the short grass areas of the Great Plains. The midcontinent, designated as semiarid and subhumid, is vulnerable to drought. This area closely correlates with the natural steppe and prairie grassland zones. The western parts are used for livestock grazing and irrigated farming and the eastern parts for various mixes of crop and livestock grazing. Agricultural activity in the Great Plains depends in large part on stored soil moisture. The area experiences significant fluctuations in precipitation and, consequently, is the most vulnerable to extreme weather conditions (USDA, 1979).

The arid regions consist of two large continuous deserts and a number of smaller isolated areas in the Southwest. In the southwestern region, the arid climate has necessitated forms of agriculture adapted to persistently low moisture conditions. Crop production depends almost entirely on irrigation. There is little variation in moisture compared to the area east of the Rocky Mountains. Comparatively, rates of evapotranspiration in relation to the meager precipitation in the Southwest result in little available soil moisture from natural processes. Dry conditions are the rule rather than the exception. The flows of many of the perennial rivers and streams are erratic. These flows originate in the higher precipitation areas of high mountain ranges.

The widely used Palmer Index measures drought by relying on parameters of the physical event itself. The index is derived from an accounting of soil moisture by relative plant requirements and moisture carryover to effective

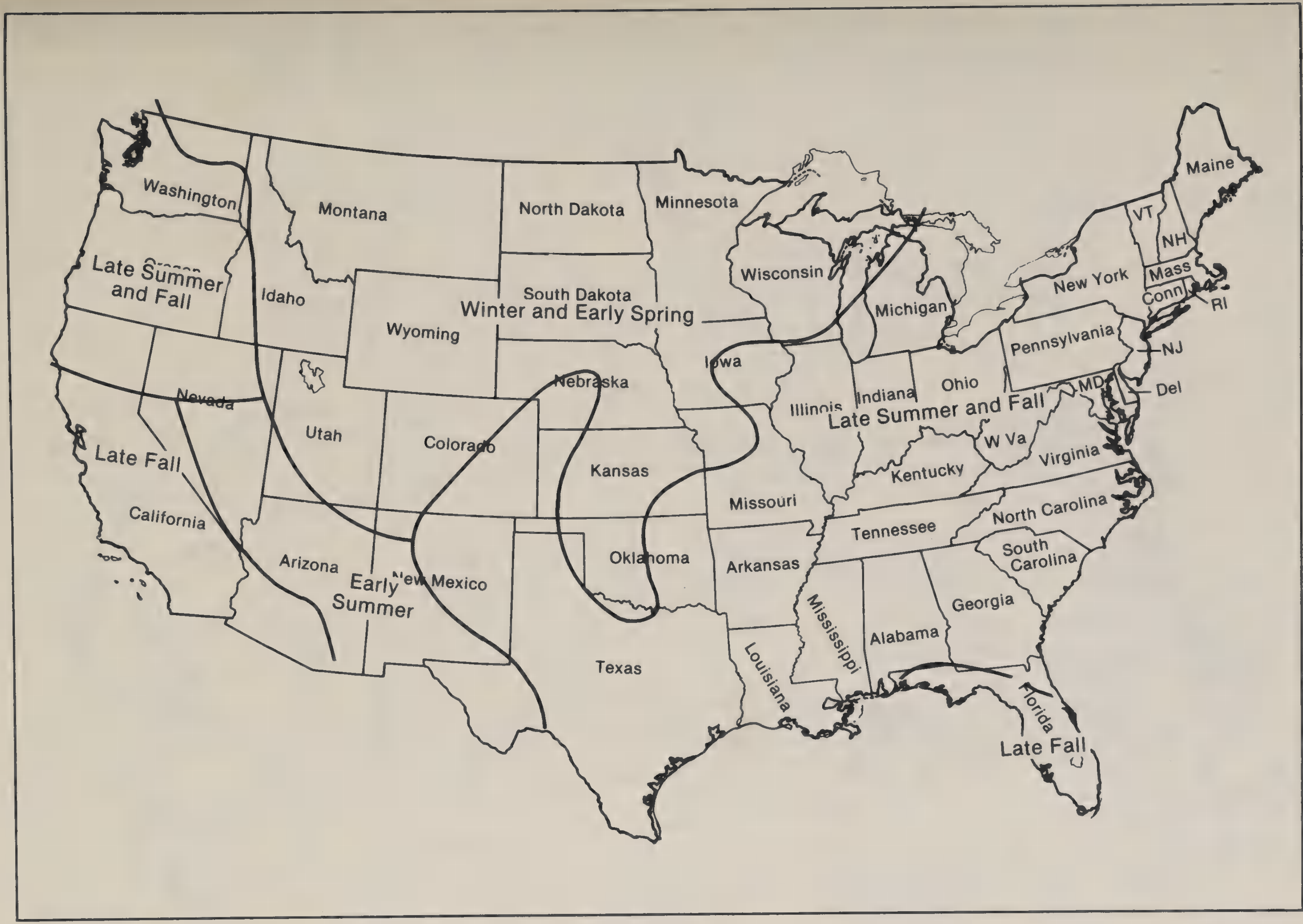


Figure 5A-10.--Seasons of lowest streamflows in the conterminous United States. (USDA. 1955. Yearbook of Agriculture.)

Figure 5A-11.--Seasons of highest streamflows in the conterminous United States. (USDA. 1955. Yearbook of Agriculture.)

Table 5A-5.--Variations in streamflow by water resources regions, "1975"

Water resources region	Monthly values				
	Low flow			High flow	
	Month	Average low flow	Average flow	Average high flow	Month
New England-------	August	35.2	78.2	205.6	April
Mid-Atlantic------	September	31.9	79.2	175.1	March
South Atlantic-Gulf-----------	November	118.5	228.0	422.8	March
Great Lakes-------	August	33.6	72.7	168.0	April
Ohio--------------	October	54.9	178.0	350.0	February
Tennessee---------	October	25.4	40.8	67.2	January
Upper Mississippi-	December	67.9	121.0	204.0	April
Lower Mississippi-	September	194.0	433.0	728.0	April
Souris-Red-Rainy--	February	1.0	6.0	18.0	April
Missouri----------	January	22.6	44.1	75.9	June
Arkansas-White-Red-------------	September	25.7	62.6	122.6	May
Texas-Gulf--------	August	9.6	28.3	56.8	May
Rio Grande--------	March	.4	1.2	3.2	October
Upper Colorado----	October	7.4	10.0	13.8	May
Lower Colorado----	October	.7	1.6	2.3	April
Great Basin-------	August	2.2	2.6	----	May
Pacific Northwest-	September	117.5	225.3	363.0	January
California--------	August	10.0	47.4	111.0	January
Conterminous U.S. 1/--------		----	1,233.4	----	
Alaska------------	March	190.0	905.0	2,070.0	June
Hawaii------------	September	2.8	6.7	11.2	April
Caribbean---------	March	2.2	4.9	8.8	October
Total 1/----		----	2,150.0	----	

Source: Second National Water Assessment (U.S. Water Resources Council, 1978b).

1/ Total excludes streamflow figures from the Ohio, Tennessee, Upper Mississippi, Missouri, Arkansas-White-Red, and Upper Colorado Regions because these are inflows to other regions.

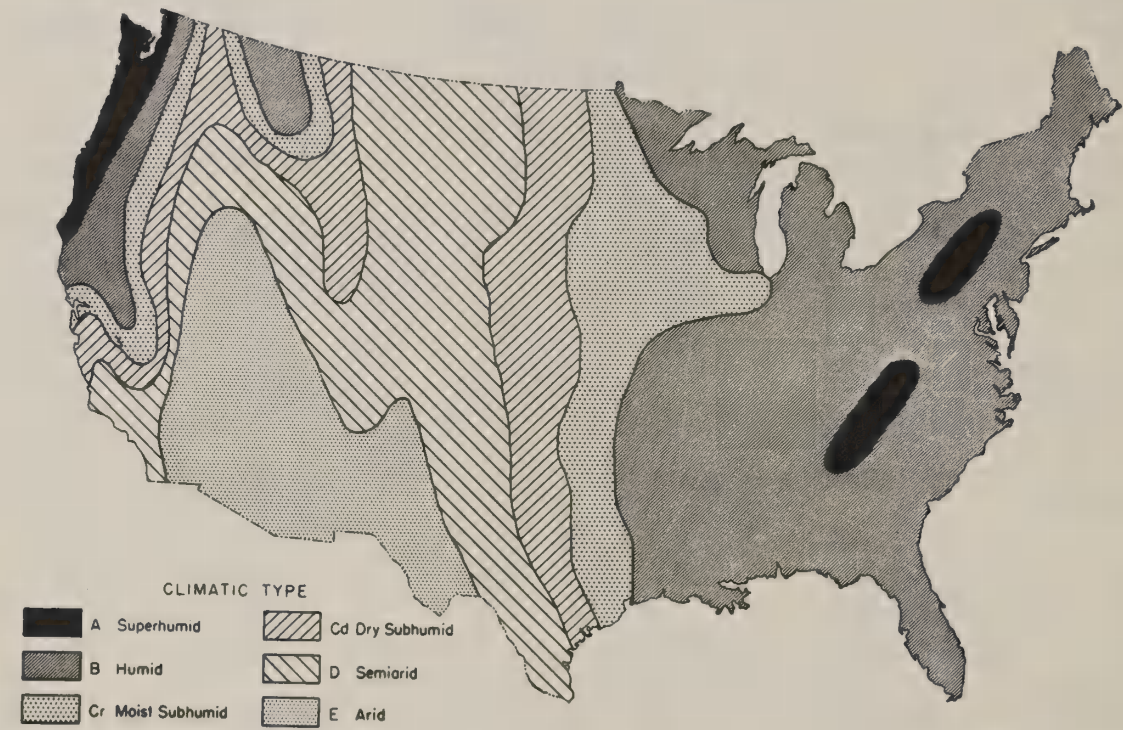


Figure 5A-12.--Generalized normal distribution of the principal climate types in the United States. (C.W. Thornthwaite. 1941. Atlas of Climatic Types in the United States, 1900-1939.)

precipitation. The index numbers for the years 1931-60, which have reasonably comparable local significance in space and time, were used to prepare an isohyetal map showing the frequency of droughts (figure 5A-13).

Excess water becomes a problem when it interferes with tillage, land preparation, plant growth, and harvesting. The plant root zone becomes saturated with free or gravitational water. This subsurface water affects aeration, biological activity, soil temperature, and structural stability and it causes farming problems. Surface runoff, deep percolation, evaporation, and transpiration remove much of the excess water, but these processes are too slow to prevent damage to crops. Farmers must resort to drainage to remove water faster. On an estimated 105 million acres of cropland, wetness is the dominant hazard (USDA, 1978b). See chapter 2.

Water intermittently covering land may be of value to wildlife. Some 23 plants with specialized tissues adapt to saturated soils. Land covered or saturated by water most of the time provides wetland habitat. These wetlands provide food and cover for migratory birds, sport and commercial fish, and other forms of wildlife including endangered species. There are about 41.5 million acres of valuable (types 3-20) wetlands in the United States (USDA, 1978a) - a fourth less than 50 years ago (CEQ, 1978). See chapter 6.

Abnormally large volumes of water from a single event or series of events can be very detrimental. Excessive erosion and flooding are the results of intense or large storms. The impact of raindrops loosens soil particles. Swiftly moving runoff also loosens soil particles, and rainwater running downslope transports these dislodged soil particles. During intense storms the energy to be dissipated by falling rain, the increased velocity of runoff, and the larger volumes of runoff all increase the rate of erosion. Figure 5A-14 shows the intensity of rainfall in a 24-hour period.

Streams and rivers do not have the capacity to carry water from abnormally heavy rainfall. Water spills over the stream channel and inundates adjacent areas. There are about 175 million acres of flood prone land. Of this total, 48 million acres are cropland, 106 million are pasture, range, and forest land, and 21 million are other land including urban and built-up areas (USDA, 1978b). Twenty-one thousand communities experience flooding problems including 6,000 with populations exceeding 2,500. In 1975, the potential damage from floods was $3.4 billion (1975 dollars). See table 5A-6.

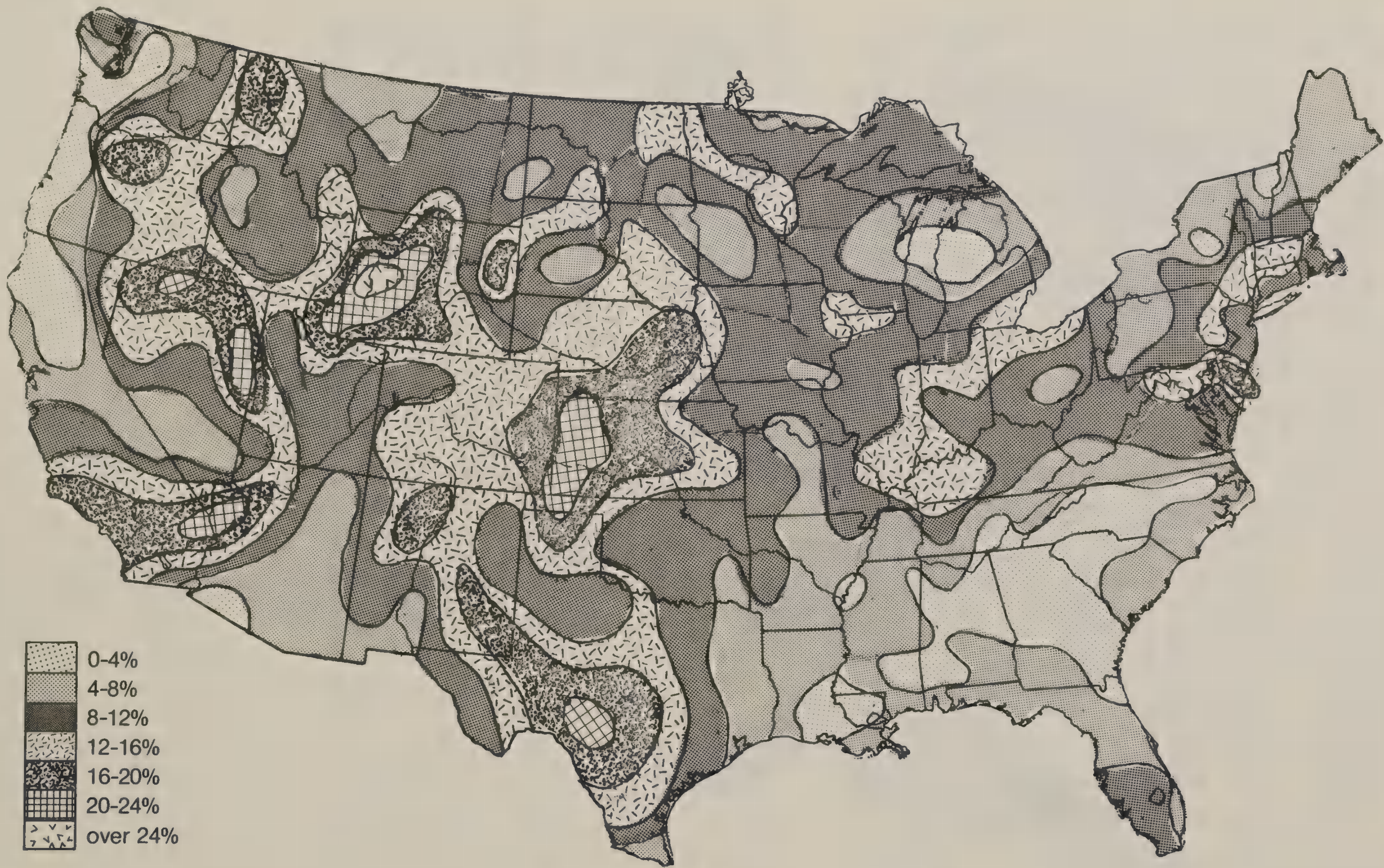


Figure 5A-13.--Percentage of months with severe or extreme drought. (U.S. Department of Commerce)

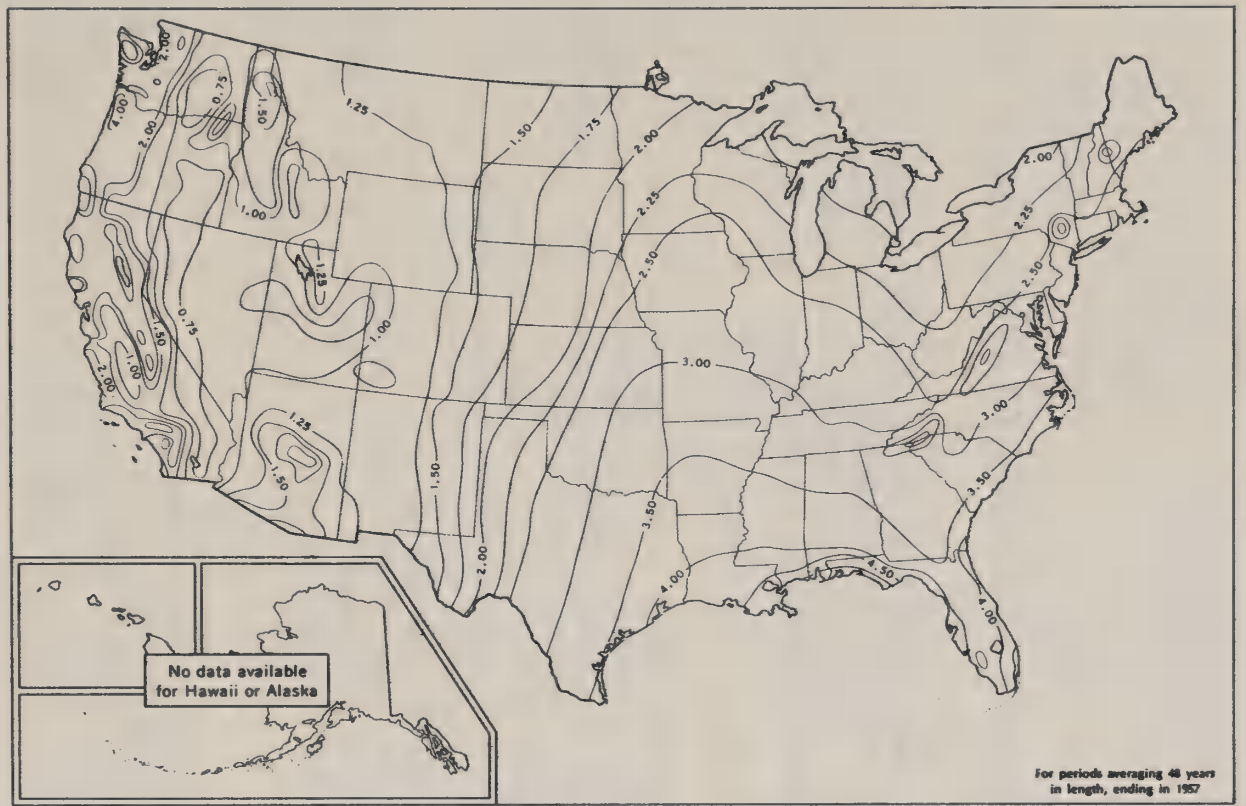


Figure 5A-14.--Mean annual maximum rainfall in 24 hours (inches).

Table 5A-6.--Flood damages--normalized 1975

	Upstream	Downstream	Total
	(Millions of 1975 dollars)		
Urban and built-up	295	852	1,147
Agricultural	1,024	611	1,635
Other (rural utilities, roads, & railways, homesteads, forest & grasslands, refuges, parks, etc.)	308	339	647
Total	1,627	1,802	3,429

Source: Second National Water Assessment (USDA, 1975a, U.S. Water Resources Council, 1978a).

Because both the number and real value of buildings and their contents are increasing, flood damages have increased. In spite of increased flood plain management, including regulation and structural measures, flood damages are expected to continue to increase. See figure 5A-15.

Availability

To reduce the seasonal variability of water in a particular area, dams and reservoirs have been constructed, upstream watersheds managed, and water transferred between regions. Available runoff and streamflow are retained for dry periods or water is moved from "water rich" to "water poor" regions. Intra- and interregional transfers of water are an important part of the total amount of water available within a given region.

The amount of runoff or streamflow in a dry year provides an indication of the dependable water supply that can be obtained from a stream. The average annual runoff is the upper limit of the supply that can be developed. The storage required to make this amount of water available may be so large that evaporation loss from the reservoirs would significantly decrease the water yield.

In some areas, storage sites or uncommitted flows are not available. Some water is not available for local use because of water rights, court decrees, interstate compacts, and international treaties. Approximately 50 compacts and treaties have been approved by Congress. Their main purpose is to allocate amounts of water among political subdivisions for downstream uses.

Ground water resources of the United States are far greater than the total capacity of all the Nation's lakes and reservoirs (including the Great Lakes). The volume is equivalent to about 35 years of surface runoff. Yet increased demands upon this resource in certain areas are causing mounting stress on the supply. Diminished water pressure, declining spring and streamflow, land subsidence, and salinity are some of the problems caused by excessive withdrawals of ground water.

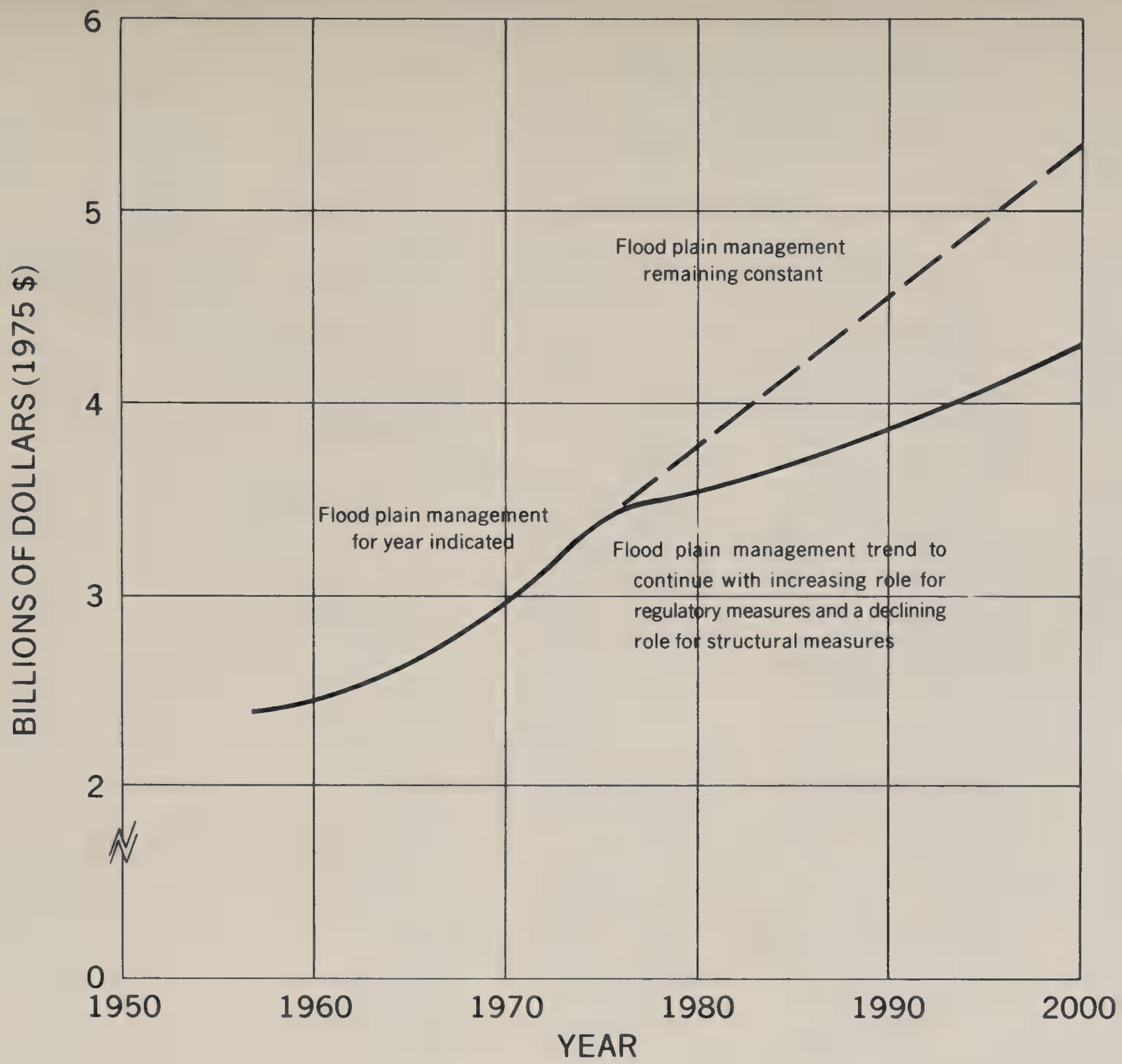


Figure 5A-15.--Flood damages, historical and projected. (U.S. Water Resources Council, 1968 and 1978c)

Brackish and saline water can satisfy some of man's requirements. The largest use of saline waters is for once-through cooling. Desalting of water has increased dramatically. Twelve desalting plants produced less than 2 million gallons a day (mgd) in 1955. Now, 336 plants produce about 100 mgd. About a third of this water is used by municipalities; the rest is used mainly by industry. But desalted water amounts to only .1 percent of the freshwater withdrawals by municipalities and industry (USWRC, 1978d).

Section B-Quality

Neither water quality nor water pollution can be defined or evaluated consistently. Water quality depends on the use desired. Even "natural" water may not meet some of man's needs. In many streams, poor water quality is not manmade. For example, studies of the Susquehanna River show that even if all human influences were removed, the water would still contain dissolved chemicals and sediment. Figure 5B-1 shows the percentage of streams in different water subregions that do not meet water quality standards.

In various areas of the world, the acidity of precipitation has been increasing during the past few decades. It varies substantially within the United States, as shown in figure 5B-2.

The concentration of nitrate ions in precipitation has increased during the past 10 years in many large areas of the Northeast. According to the U.S. Environmental Protection Agency, emissions of both sulfur dioxide and nitrogen oxides increased sharply after 1960 (USWRC 1978a). The increase in nitrate concentrations parallels the increase in the acidity of precipitation. In addition, the use of nitrogen fertilizer has increased rapidly since about 1950, and the conversion of fertilizer to gaseous nitrogen by soil microorganisms may add nitrogen oxide to the atmosphere and to precipitation.

Water pollution is a matter of definition just as water quality depends on the use desired. What is considered polluted water depends on the substances defined as pollutants, and the quantity set as an acceptable limit. Data are inadequate to characterize pollutant generation by source, especially of diffuse sources on a nationwide basis. Figures 5B-3 through 5B-7 (EPA, 1978) indicate where particular pollutants from nonpoint sources are a problem.

Agriculture is the most widespread cause of nonpoint source pollution. This pollution can come from runoff or from irrigation return flow. Runoff generally increases the levels of infectious agents, suspended solids, nutrients, and pesticides. Irrigation return flow primarily increases the level of dissolved solids, nutrients, and pesticides.

Infectious agents

Polluted streams may carry bacteria, fungi, and viruses that can cause disease in plants, animals, and humans. The presence of fecal coliform, although not harmful, indicates a potential hazard to human health. These bacteria indicate that water contains fecal matter that can transmit disease bacteria and viruses, including typhoid fever, hepatitis, brucellosis, encephalitis, poliomyelitis, prittacosis, and tuberculosis. Sources of bacteria are both point--effluents from municipal treatment plants and feedlots--and nonpoint--combined sewer overflows, septic fields, urban and agricultural runoff, and natural sources such as migrating waterfowl that congregate in large numbers at certain water bodies (figure 5B-3). Vectors are insects such as mosquitoes or other organisms that directly or indirectly transmit a disease agent or cause annoyance or irritation to man. They breed profusely in polluted waters.

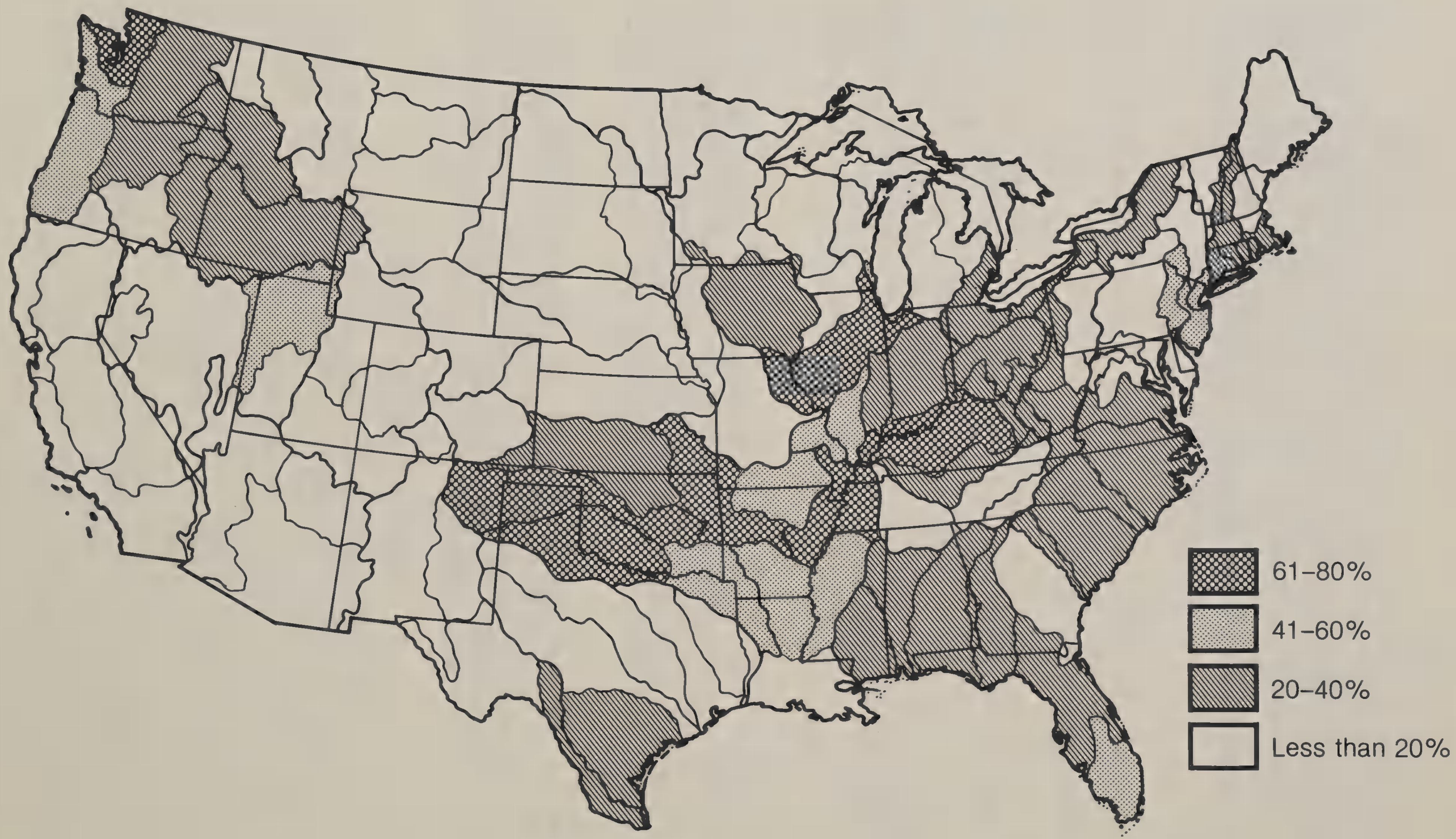


Figure 5B-1.--Percentage of streams having limited water quality.

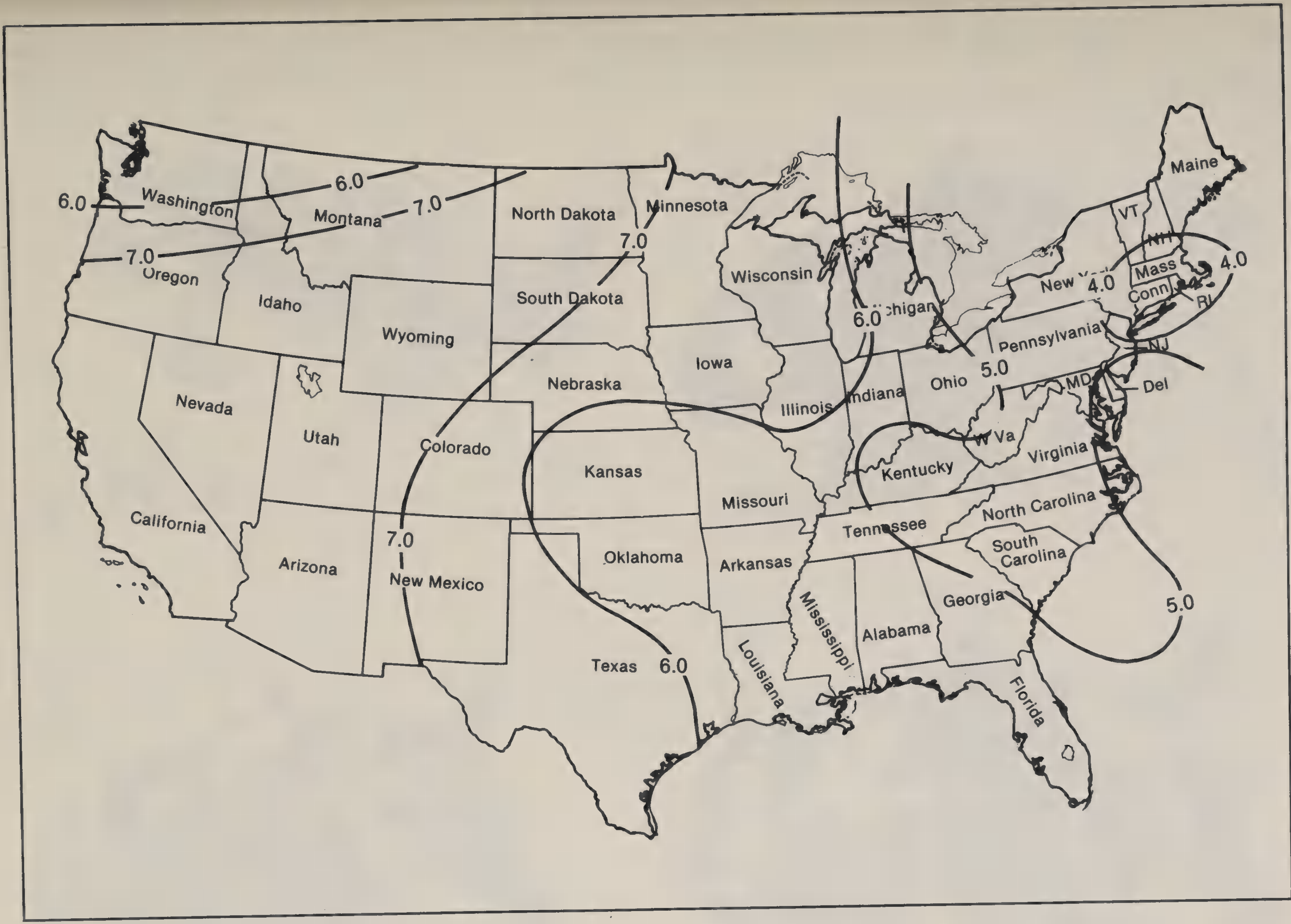


Figure 5B-2.--Acidity of precipitation in the United States (pH). (U.S. Water Resources Council, 1978d)

■ Represents basins affected by specific pollutant

Figure 5B-3.--Pollution problems--bacteria from nonpoint sources (top left). (EPA, 1978)
Figure 5B-4.--Pollution problems--nutrients from nonpoint sources (top right). (EPA, 1978)
Figure 5B-5.--Pollution problems--total dissolved solids from nonpoint sources (bottom right). (EPA, 1978)

■ Represents basins affected by specific pollutant

Figure 5B-6.--Pollution problems--suspended solids from nonpoint sources (left). (EPA, 1978)
Figure 5B-7.--Pollution problems--pesticides from nonpoint sources (right). (EPA, 1978)

Nutrients

Plant nutrients removed by leaching or transported by sediment and runoff may produce two pollution problems: (1) ground water contaminated by small amounts of nitrite that can be toxic to cattle and cause methemoglobinemia in infants (blue baby) and (2) accelerated eutrophication of surface waters which is caused by the discharge of nutrients that overstimulate aquatic growth in the receiving waters. The overstimulated aquatic weeds and algae can reduce the dissolved oxygen for fish, make water unsuitable for recreation, interfere with small boat navigation, and be esthetically displeasing. The resulting problems can be surface scum, foul odors, and dead fish. Nutrients from nonpoint sources are widespread (figure 5B-4).

Natural nitrification in soils and nitrification of sewage effluent and animal wastes are major contributors of nitrates found in ground water. Animal waste and septic tank drainage near improperly constructed shallow wells are the main contaminators of rural water supplies.

Eutrophication occurs naturally as a body of water ages geologically. The process is accelerated when nutrients are added. There are 21 essential elements required for plant growth. The limiting nutrient is the one that is present in the lowest concentration relative to the concentration required to stimulate aquatic plant growth. Phosphorus and nitrogen are most often the limiting nutrients (table 5B-1).

Table 5B-1.--Results from a survey of eutrophication in lakes

Limiting nutrient	Number of lakes	Percentage of lakes
Phosphorous	417	67
Nitrogen	186	30
Other	20	3
Total	623	100

Source: Table N-2 NWQI - 1975 Report to Congress (Environmental Protection Agency, 1975).

Phosphorus and nitrogen enter waterways from sewage treatment plant discharges, leachates from septic fields, atmospheric fallout, certain industrial waste discharges and runoff containing organic material, and agricultural runoff and irrigation return flows.

Land use, geology, soils, climate, and geographic factors determine the nutrient levels in lakes. Streams draining agricultural areas have total phosphorus concentrations of 0.135 milligrams per liter (mg/l) compared to 0.014 mg/l for streams draining forested areas; they have nitrogen concentrations of 4.17 mg/l compared to 0.85 mg/l for streams in forested areas (EPA, 1975b). Agricultural residues of nitrogen and phosphorus may enter

water supplies from runoff and leaching associated with animal wastes, from commercial fertilizer and crop residues, and from sediment carrying nutrients (table 5B-2).

Table 5B-2.--Nutrient content of organic wastes and fertilizer

Material	Total weight dry matter	Nutrients: Nitrogen (N)	Phosphorus (P)	Potassium (K)
		(million tons)		
Organic waste				
Animal manure-------------	175	7.7	1.9	4.2
Other ------------------- (includes crop residues, municipal refuses, industrial organic sludge, food processing, logging, and wood manufacture)	628	5.8	2.0	5.8
Commercial fertilizer--------	50	10.6	2.5	4.8
Range of estimates of loss to water supplies from rural agricultural land----		0.75-7.5	0.06-0.6	

Source: Improving Soils with Organic Wastes (USDA, 1978b).
SCS Rural Clean Water Program, Environmental Impact Statement (USDA, 1977).

Dissolved Solids

Salinity is the term generally used to describe concentrations of dissolved minerals or solids in water. Salinity can corrode metals and damage fabrics, and it can have negative effects on drinking water, livestock, and irrigated crops. Abrupt changes in background salinity levels may be lethal to aquatic life.

Salinity problems are found in coastal areas where seawater intrusion may occur. Salty ocean water pushes into depressurized ground-water storage areas, and tidewater moves upstream during low flow periods. There are also problems in irrigated arid and semiarid regions. In these regions, additional salt is loaded into streams. Salt concentrations also increase after some water is consumed and a smaller amount is returned to the stream. Water erosion adds a portion of the 90 million ton annual salt yield. Except for the Columbia River, all the drainage systems in the West have high salinity levels in their tributary rivers (see figure 5B-5).

In most streams in arid and semiarid regions salinity increases progressively from headwaters to outlets. For example, the concentration of mineral salts increases about 20 times from the Colorado River headwaters in Colorado to the Imperial Dam in Arizona (USDI, 1975). Of the 10 million

tons of salt carried annually in the Colorado River, natural sources account for two-thirds and irrigation return flows account for one-third. The yearly damages attributed to salinity in the Colorado River System in the United States as of 1973 amounted to $53 million (Leisher and Group B, 1979).

Geologic variations in salinity levels are largely natural, but human activity can have a significant influence, particularly in areas where water is scarce. Salinity is significant in about 20 percent of the soils in the western states; erosion control in these areas could reduce salt loading by 2 percent.

Suspended Solids

Soil particles, organic matter, plankton, and other substances in the water column reduce light transmission through the water. This inhibits the growth of underwater plants and interferes with nursery grounds or other habitats of aquatic life. These particles can also settle to form oxygen-demanding sludge deposits, cause esthetic degradation, and act as transport agents for other pollutants. Suspended solids are a widespread problem (figure 5B-6).

According to the National Residuals Discharge Inventory, two-thirds of the 2.1 trillion pounds per year of total suspended solid (TSS) residuals discharged into receiving waters were from nonpoint sources (Leisher and Group B, 1979). Sediment makes up by far the largest part of suspended solids. Sediment runoff occurs naturally but is accelerated by agriculture, silviculture, mining, and construction (table 5B-3). Other significant sources of suspended solids include dredge and fill operations, wave turbulence, and urban runoff.

Table 5B-3.--The percentages of sediment yield from different sources

Sediment source	Contribution (percent)
Streambank	26
Cropland	40
Pasture and rangeland	12
Forest land	7
Roadside	3
Urban	4
Mining	1
Other	7
Total	100

Source: SCS Rural Clean Water Program, Environmental Impact Statement (USDA, 1977)

Erosion from cropland is of special concern because it is a major contributor to sediment which carries nutrients and pesticides into streams.

Pesticides

Chemical compounds used to kill pests may become toxic pollutants. These chemicals are mixed into more than a billion pounds of pesticides annually, including nonaquatic and aquatic herbicides and growth regulators, insecticides, acaricides, fumigants, nematocides, and rodenticides. They help to produce, protect, and improve our food, suppress vectors, eliminate poisonous plants in wildlife grazing areas, and reduce weed growth in water so food plants needed by fish can grow.

Nevertheless, chemical pesticides are poisons. Pesticide residues pollute receiving waters in four ways--atmosphere (spray), sediment runoff, effluent, and accumulation (figure 5B-7). Pesticides, like heavy metals and industrial toxics, are dangerous to man because material introduced into the food chain can persist and accumulate over long periods. They can disrupt the stability of the ecosystem and, thereby, affect man. Toxicants can have adverse effects on organisms even in concentrations below detectable limits. Toxics can result in death, impaired health, reproductive failure, or other damage.

Annual pesticide production in the U.S. increased from 0.3 billion pounds in 1950 to 1.6 billion pounds in 1975 (CEQ, 1978). It has declined slightly since 1975. Farmers used about 60 percent of the 1.5 billion pounds produced in 1977. About half of the pesticides are herbicides. About 45 percent of all herbicides are used in corn production. About 47 percent of all the insecticides are applied to cotton. Pesticide application averages 2.6 pounds per cropland acre excluding hayland (USWRC, 1978c).

There has been a decline in the levels of some pesticides in water. Measured levels of five suspended or cancelled pesticides have more frequently shown as improving rather than a worsening situation (table 5B-4). Diet intake of pesticides has dropped substantially (table 5B-5).

Table 5B-4.--Measurements of the pesticides in water: 1966-70 versus 1971-76

	Percentage of data cells showing--		
Pesticide	Decline	Little change	Increase
DDT	78	3	19
Endrin	95	0	5
Chlordane	89	1	10
Dieldrin	76	7	17
Aldrin	91	1	8

Source: Environmental Protection Agency, STORET System, (EPA, 1978).

Table 5B-5.--Diet intake of pesticides

Year	Pesticides in mg/day
1966	0.156
1970	0.067
1974	0.056

Source: Environmental Statistics. (Council on Environmental Quality, 1978).

Except when heavy rainfall occurs directly after treatment, concentrations are very low, and the total amount of pesticide that runs off the land during the crop year is generally less than 5 percent.

However, some chemicals are highly toxic to fish or other aquatic forms and can persist in the aquatic environment for a long time so that even very low levels of these pesticides are of environmental concern.

Quality problems are exacerbated by variations in streamflow that affect the dilution of sanitary wasteloads. For example, in many cases, the 10-year, 7-day low flows (see glossary) are smaller than treated effluent discharges. At the other extreme, during high flow periods, most surface waters display their poorest quality, with significant increases in biological oxygen demand, nutrients, bacteria, and turbidity from nonpoint sources. It is important that water quality and water quantity be considered together in water management plans.

Section C-Use

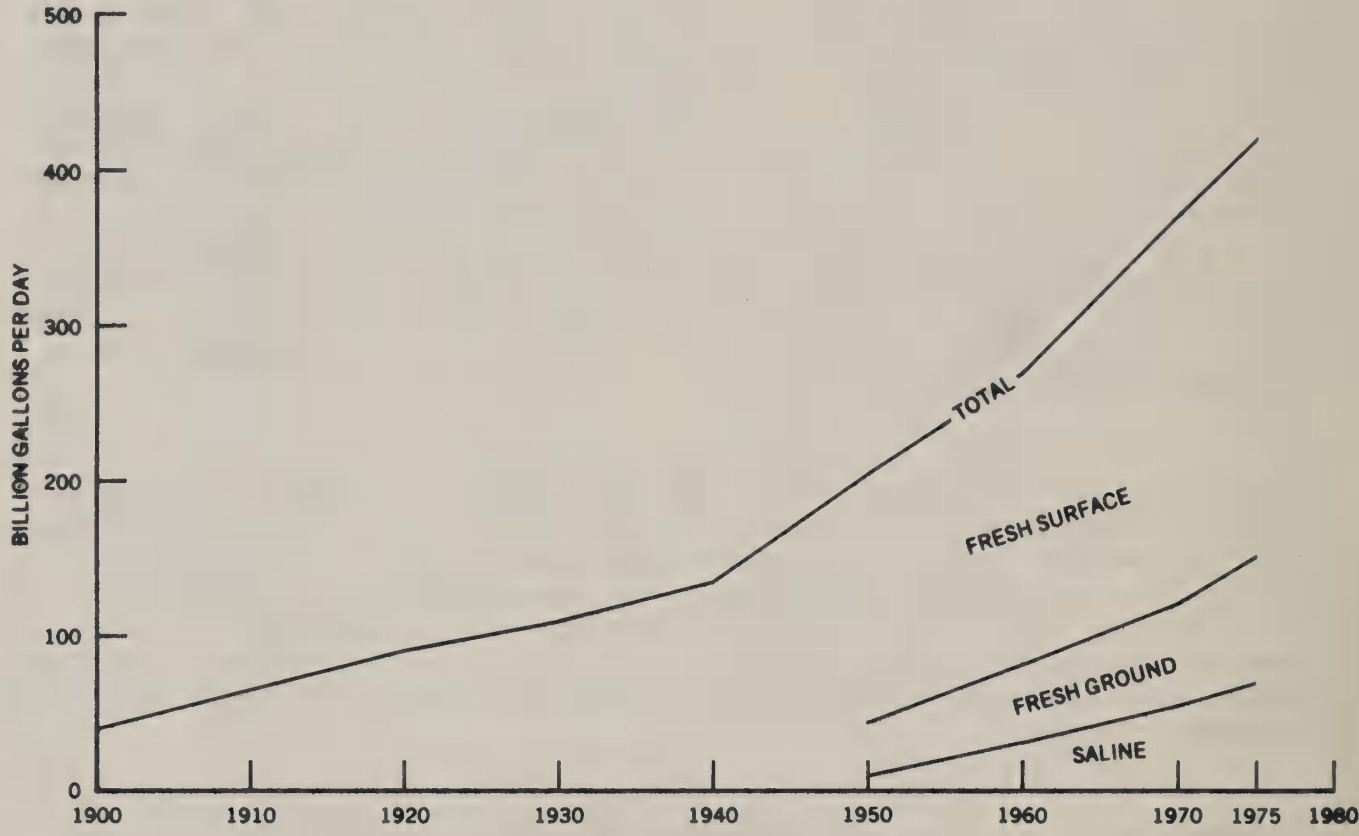
About two-thirds of the combined withdrawals of fresh (339 bgd) and saline (60 bgd) water in the United States and the Caribbean came from fresh streamflow and surface storage sources in "1975" according to the base year data in the Second National Water Assessment. (Data on water use are for a normalized year "1975" and do not represent actual water use.) An additional 15 percent (61 bgd) came from ground water sources that interact greatly with streamflows. Thus, 80 percent of the water withdrawn came from replenishable fresh surface and ground water sources. The remaining sources of water were saline (15 percent) and ground water mining (5 percent). Figure 5C-1 shows the sources of water withdrawals since 1900 based on data from the National Water Commission and the Geological Survey (USWRC, 1978d). Figure 5C-2 shows sources of water withdrawals by water resources regions (USWRC, 1978e).

Approximately 339 billion gallons per day (bgd) of freshwater were withdrawn in "1975" from ground and surface water sources for irrigation, municipal and household use, manufacturing, mining, electric power generation, and other uses. About 232 bgd were returned to surface water. The remaining 107 bgd were consumed through evapotranspiration or incorporated into products. An additional 60 bgd were withdrawn from the oceans, to which most of the saline water was returned. See table 5C-1 and figures 5C-3a and b.

A number of water uses generally do not reduce supplies. For instance, lakes, reservoirs, wetlands, streams, and rivers provide fluvial and riparian habitat for fish and wildlife. They also provide waterways for navigation, recreation, and esthetic purposes.

Offstream Requirements

Irrigation.--Of the 339 bgd of freshwater withdrawn for offstream use, 159 bgd were used for irrigation. The amount of water consumed (evapotranspired to the atmosphere) by irrigation was high--86 bgd. (The other 73 bgd were return flow.) Only 20 bgd were consumed by all other uses. An estimated 92 percent of the water consumed by irrigation occurred in the chronically dry regions of the West. See figure 5C-4.



Sources: Years 1900-1940: National Water Commission, Water Policies for the Future, Table 1, p. 7.
Years 1950-1975: USGS, "Estimated Uses of Water in the United States", Geological Survey Circular 765, Table 3, p. 10.

Figure 5C-1.--Sources of water withdrawals since 1900.

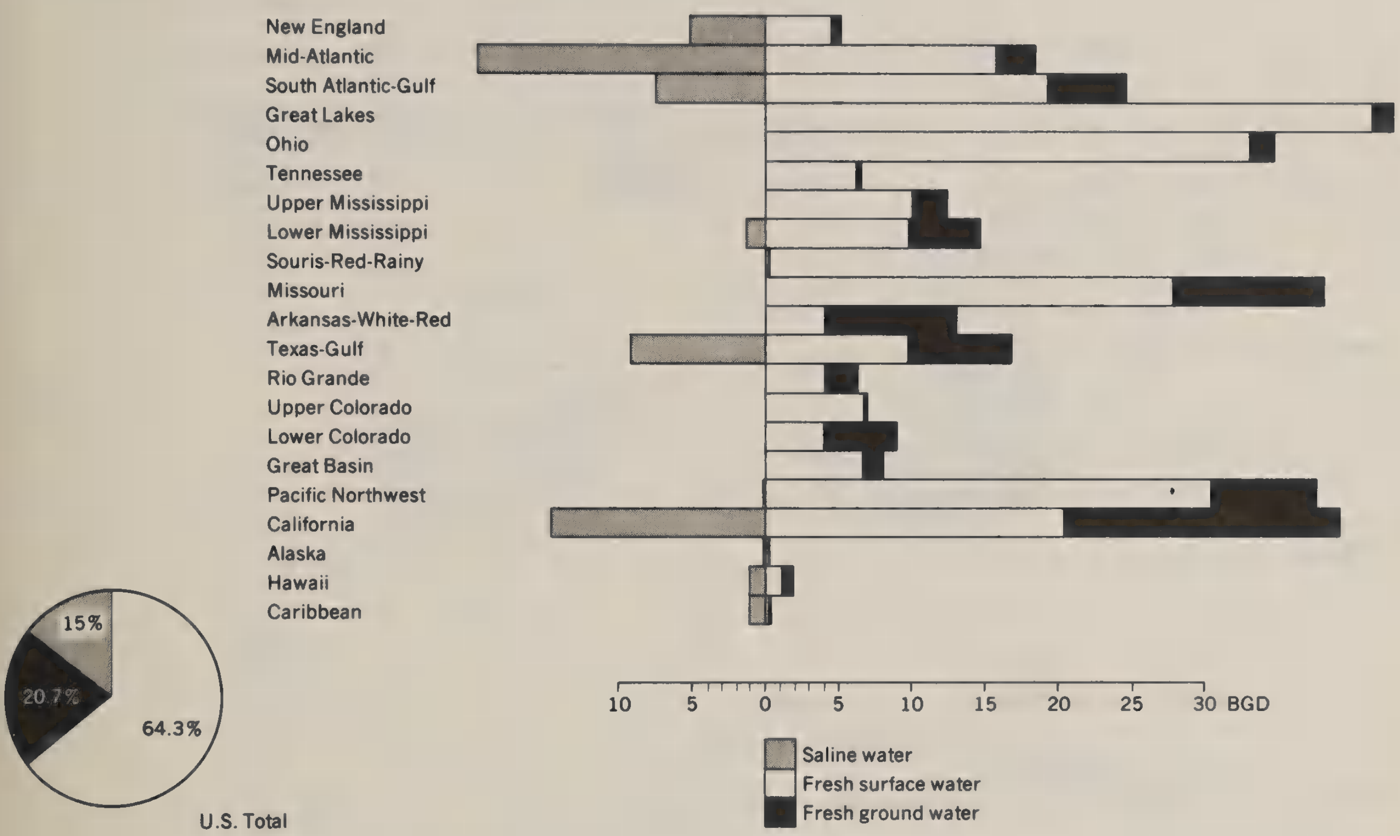


Figure 5C-2.--Existing sources of water withdrawals.

Table 5C-1.--Annual water requirements for offstream uses for the 21 water resources regions "Normalized" 1975 - average year

Type of use	Withdrawals	Consumption
	(Billion gallons per day)	
Domestic and commercial		
Central (municipal)--------------	21.2	5.0
Noncentral (rural)---------------	2.1	1.3
Commercial-----------------------	5.5	1.1
Manufacturing--------------------------	51.2	6.0
Agriculture		
Irrigation------------------------	158.7	86.4
Livestock-------------------------	1.9	1.9
Steam electric------------------------	88.9	1.4
Minerals------------------------------	7.1	2.2
Other (fish hatcheries, public lands, etc.)---------------------------	1.9	1.2
Subtotal, freshwater------------------	338.5	106.5
Subtotal, saline----------------------	59.7	----
Total----------------------------	398.2	106.5

Source: Second National Water Assessment (U.S. Water Resources Council, 1978e)

The number of irrigated acres has increased rather dramatically since 1940 when only 21 million acres were irrigated. See figure 5C-5. Of the 335 million acres of cropland harvested in 1975, an estimated 39 to 45 million acres were irrigated. Seven million acres of nonharvested cropland and pasture were also irrigated. An additional 10 to 16 million acres of land are irrigated, but not every year. It is likely that 7 to 17 million acres more may be irrigated by the turn of the century. Based on the conservative figure of 7 million more acres, the water consumed annually by irrigation would increase from 96 million acre-feet (86 bgd) to 118 million acre-feet (105 bgd) by the year 2000.

Irrigation allows use of better land--more productive and less erodible land. It allows timely operation and far more efficient use of production inputs, including energy. Lack of precipitation is the greatest single

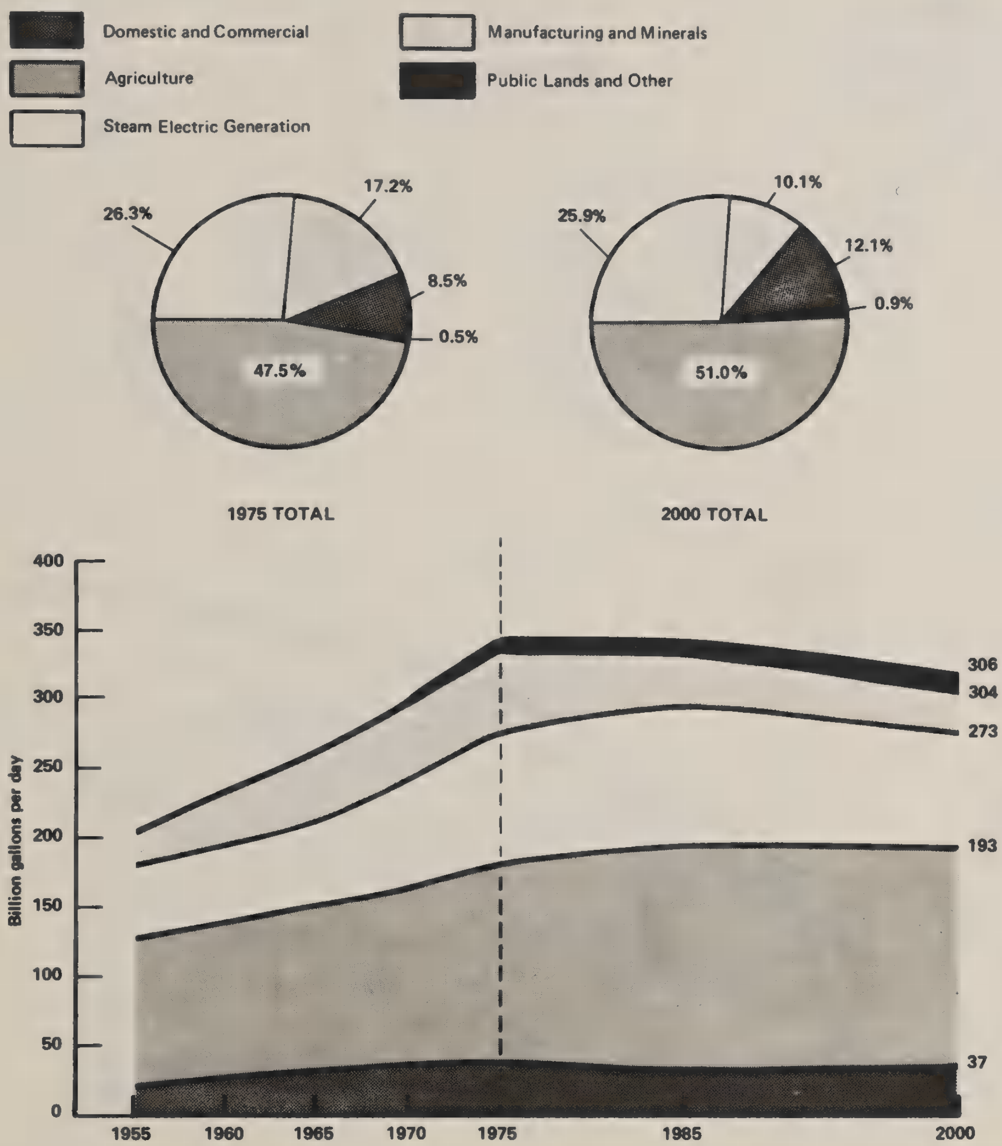


Figure 5C-3a.--Withdrawals by functional use. (U.S. Water Resources Council, 1978e)

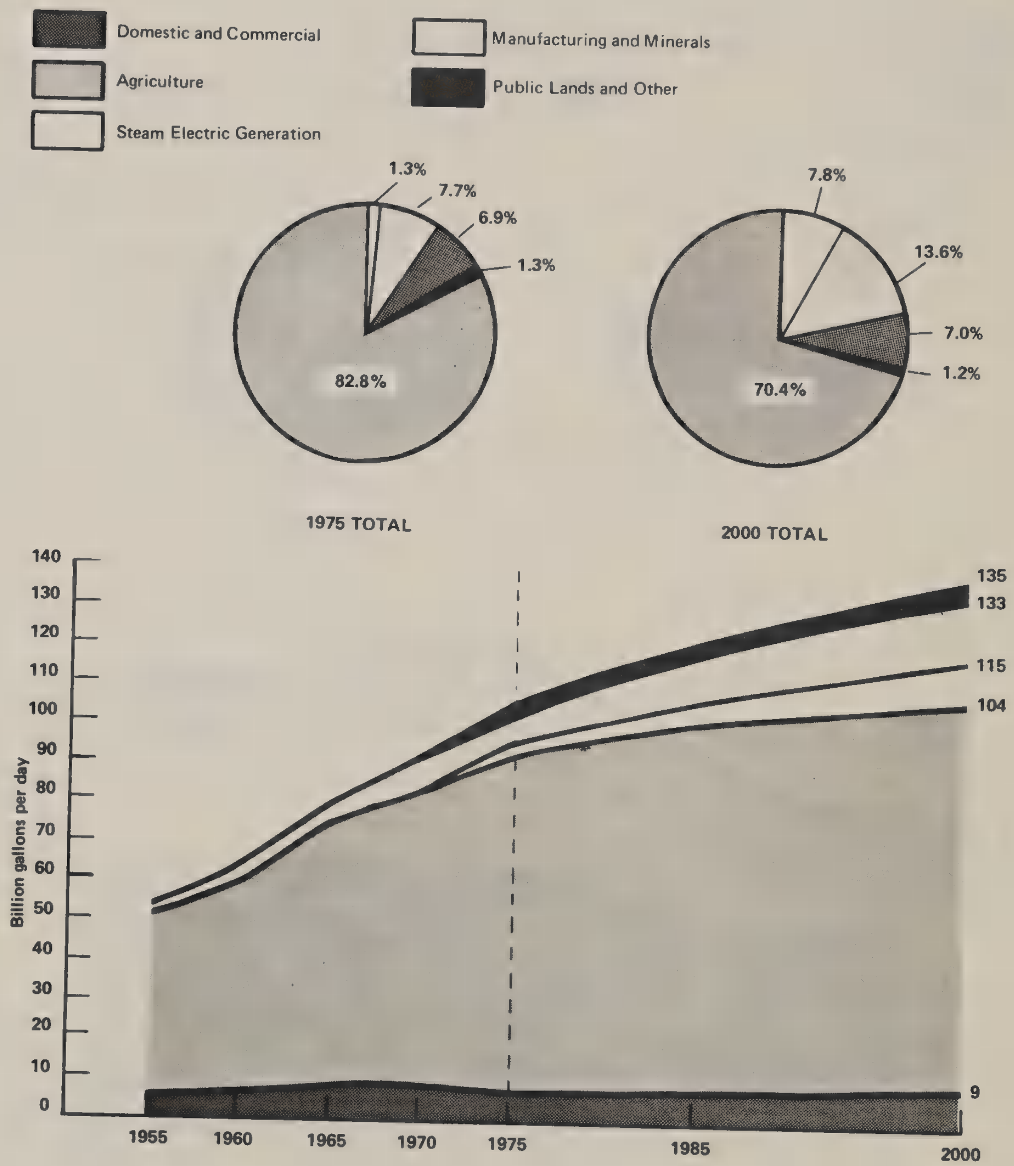


Figure 5C-3b.--Consumption by functional use. (U.S. Water Resources Council, 1978e)

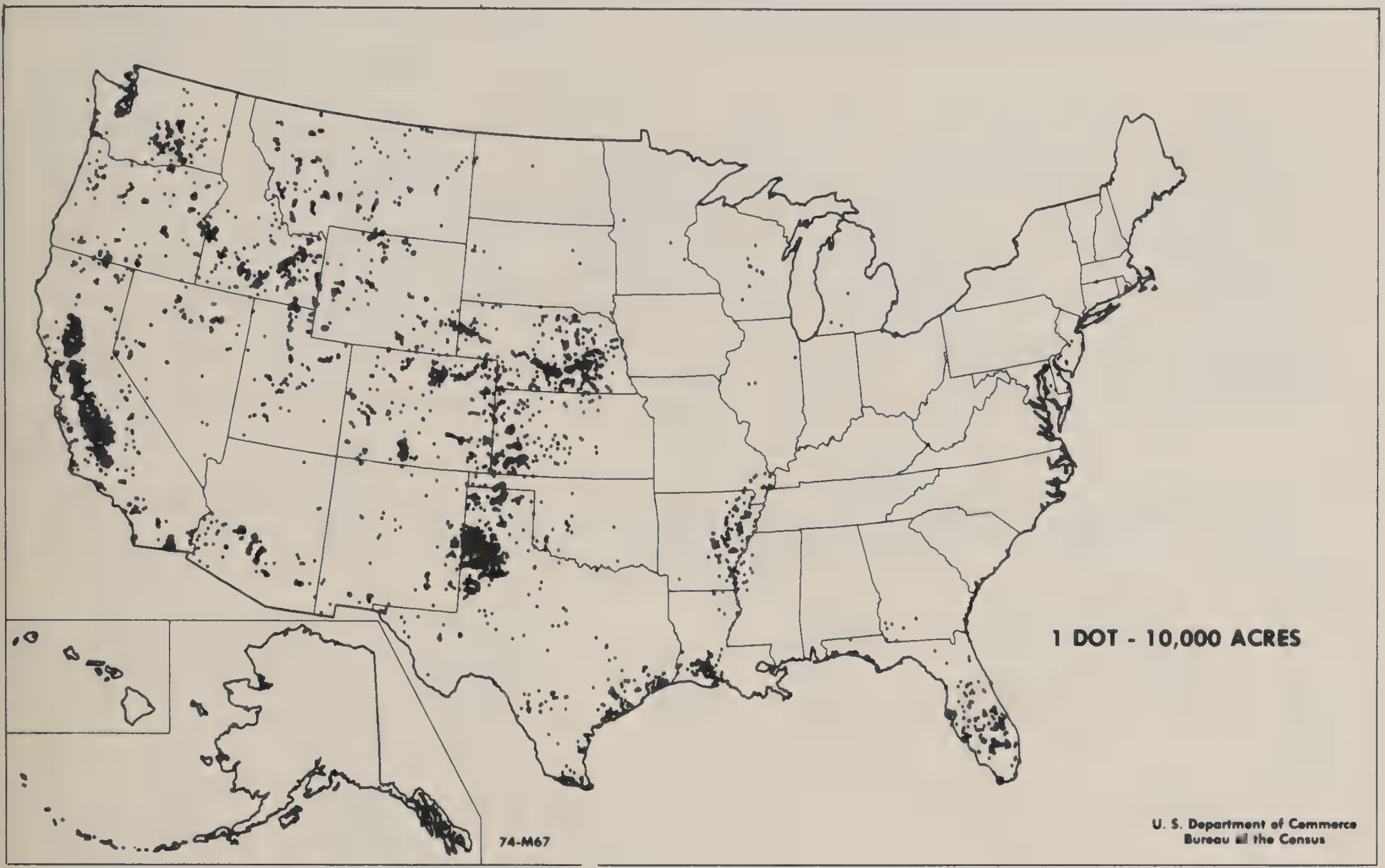


Figure 5C-4.--Location of irrigated land, 1974.

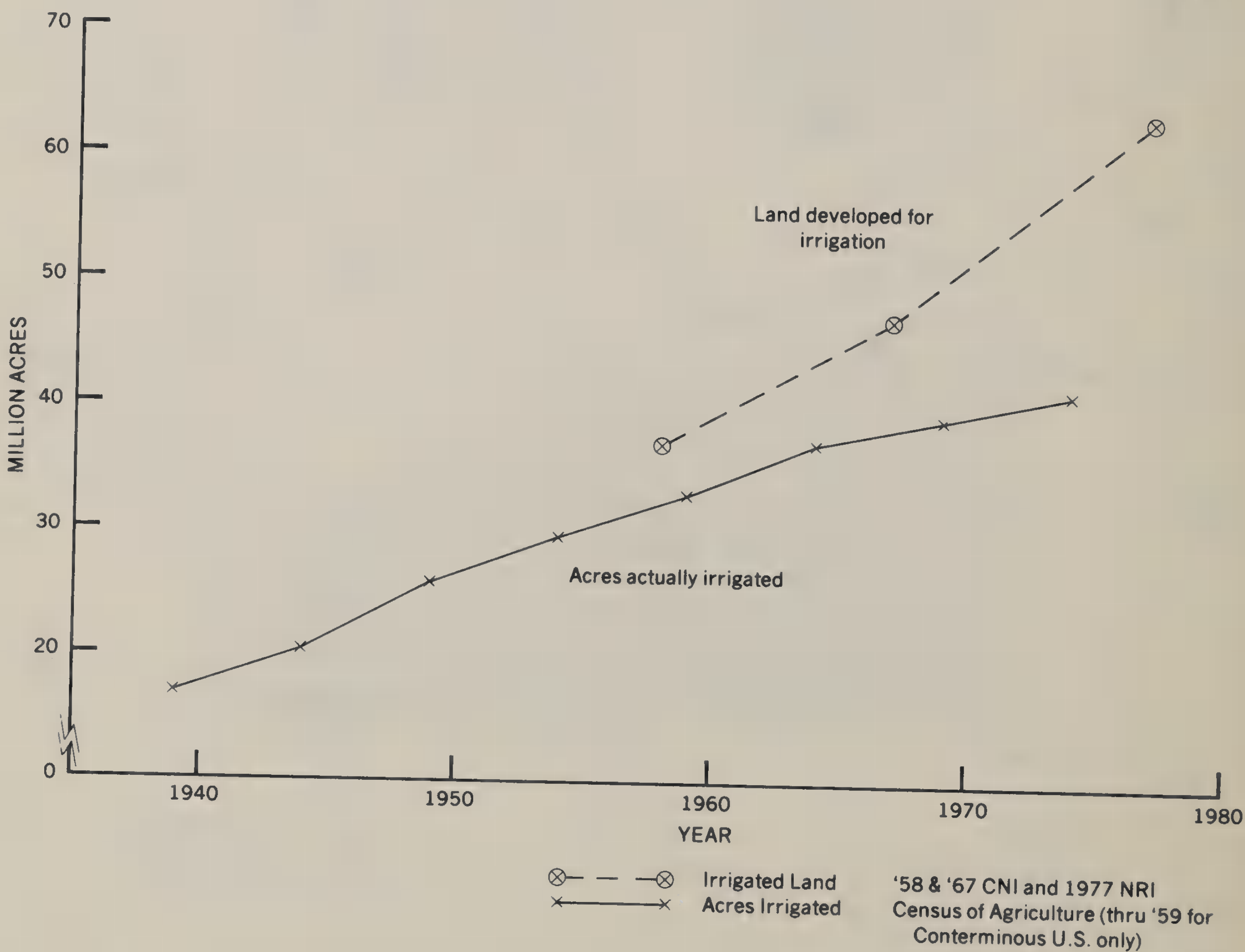


Figure 5C-5.--Irrigated land, 1939-1977.

climatic cause of below-normal yields. Irrigation is used throughout the United States to reduce the economic risk of drought and to ensure crop quality. Irrigated agriculture on only 12 percent of the cropland in the United States accounts for more than 25 percent of the value of all crops produced (USDC, 1974).

Irrigation efficiencies average 78 percent for conveyance and 53 percent for onfarm systems nationally (USDA, 1976). See figure 5C-6. Inefficient irrigation may degrade water quality, cause irrecoverable losses, use excessive energy for pumping, and reduce instream flows. Return flows are important to downstream water rights and uses (USDA, 1976). The potential water savings through conservation tend to be small--a portion of the 20.8 mgd of incidental losses. The primary benefits of water conservation are often offsite rather than onsite. They frequently do not materially help the irrigator who conserves water. (Interagency Task Force on Irrigation, 1978).

Livestock.--An average 1.9 bgd of water were used directly to produce red meat, poultry, eggs, and milk. The number of bgd's used to produce selected products are listed below (USDA, 1975b).

Beef and veal	1.24	Poultry meat	0.05
Lamb and mutton	0.05	Eggs	0.03
Pork	0.18	Milk	0.36

The estimated number of bgd's of water used in maintaining livestock can be broken down as follows:

Drinking water	1.09
Evaporation from stockwater ponds	.51
Dairy sanitation, cleaning, and waste disposal	.18
Cooling and processing (egg washing)	.02
Water losses (overflows, refills, etc.)	.11

The use of water for livestock in the United States and the Caribbean water resources region is expected to increase from the 1.9 bgd used in "1975" to more than 2.5 bgd by 2000. The increase will be the result of greater livestock production rather than larger quantities of water being used per unit of production. Consumption is considered equal to withdrawal. Some 42 percent of the water used for livestock is surface water.

Water shortages and unpalatable and unhealthy water supplies are severe problems for sustained production of livestock. Insufficient water for livestock is a severe problem in the arid West and on the Hawaiian and Caribbean Islands. The distribution of water supplies is a severe problem in semihumid areas. Water quality problems throughout the Nation inhibit livestock production. See figure 5C-7. Intrusion by salt water has destroyed some freshwater aquifers along the coastline. Serious problems with sedimentation, eutrophication, and access to supplies are widespread.

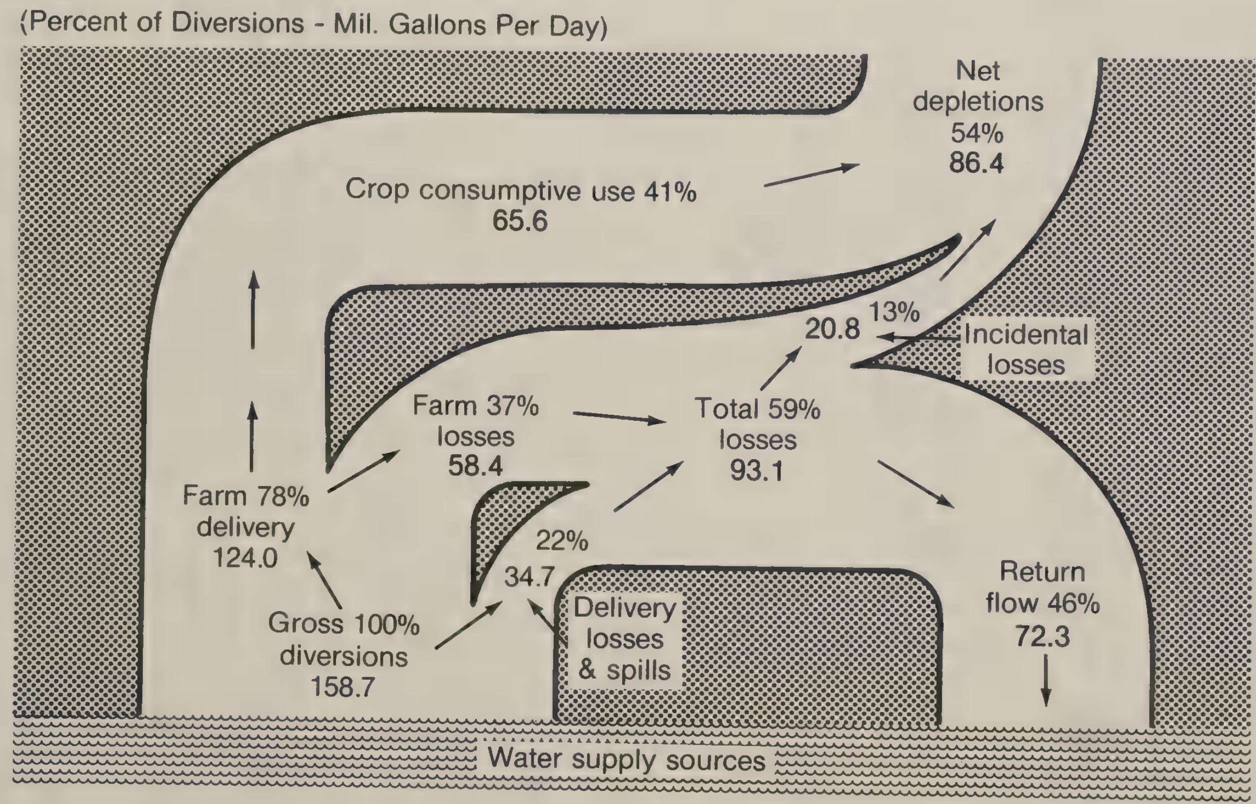


Figure 5C-6.--Irrigated water budget.

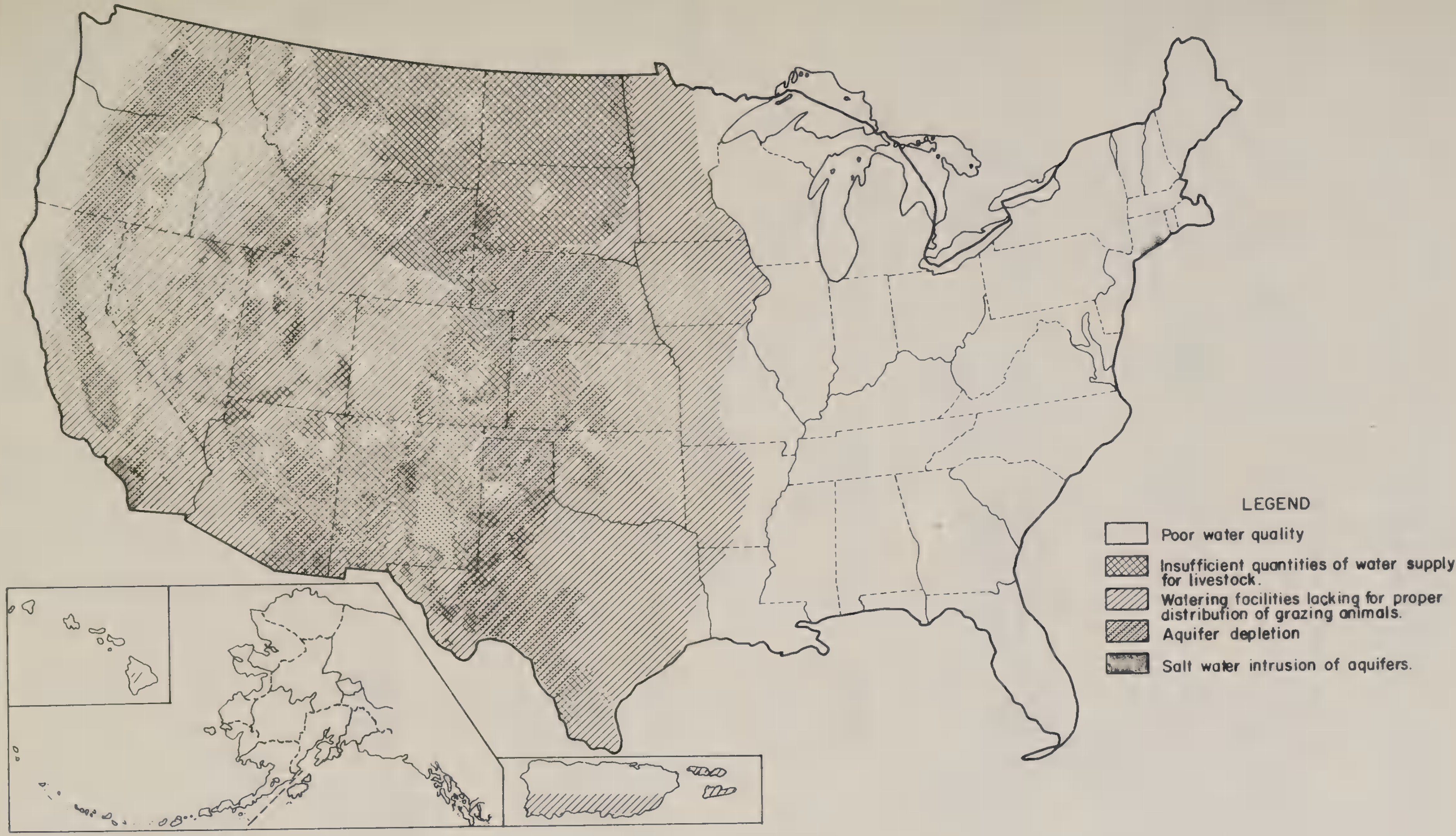


Figure 5C-7.--Location of severe livestock watering problems.

Domestic Use.--Household water use was estimated at 23.3 bgd withdrawal and 6.3 bgd consumption in "1975." Of this volume, about 2.1 bgd were withdrawn and 1.3 bgd consumed by households that are not served by a central supply system.

In 1975, about 83 percent of the households used water supplied by a central system--public systems or private companies. See figure 5C-8. The other 17 percent was made up of households that had their own water supply systems (self-supplied, noncentral) in the form of an individual well or other sources. The other sources included springs, creeks, ditches, rivers, lakes, ponds, cisterns, and catchments. Most of the households with self-supplied systems are in rural areas. Some do not have running water under pressure; about 3 percent of the housing units have water carried into them.

Both the number of households and the proportion of the population served by self-supplied systems are decreasing. Table 5C-2 shows holdholds served by different sources of water in 1960 and 1970. Table 5C-3 shows estimates of United States population served by central and noncentral systems in 1969 and 1970.

Table 5C-2.--Households served, by source of water: 1960-1970

Subject	1960	1970
	(Thousands of households)	
All housing units-----------------------	58,318	67,656
Source of water		
Central system (public and private)----	45,007	55,258
Self-supplied system (total)-----------	13,311	12,398
Individual well----------------------	11,138	11,100
Other--------------------------------	2,173	1,298
	(Percentage of households)	
Source of water		
Central system------------------------	77.2	81.7
Self-supplied system------------------	22.8	18.3

Source: 1970 Census of Housing

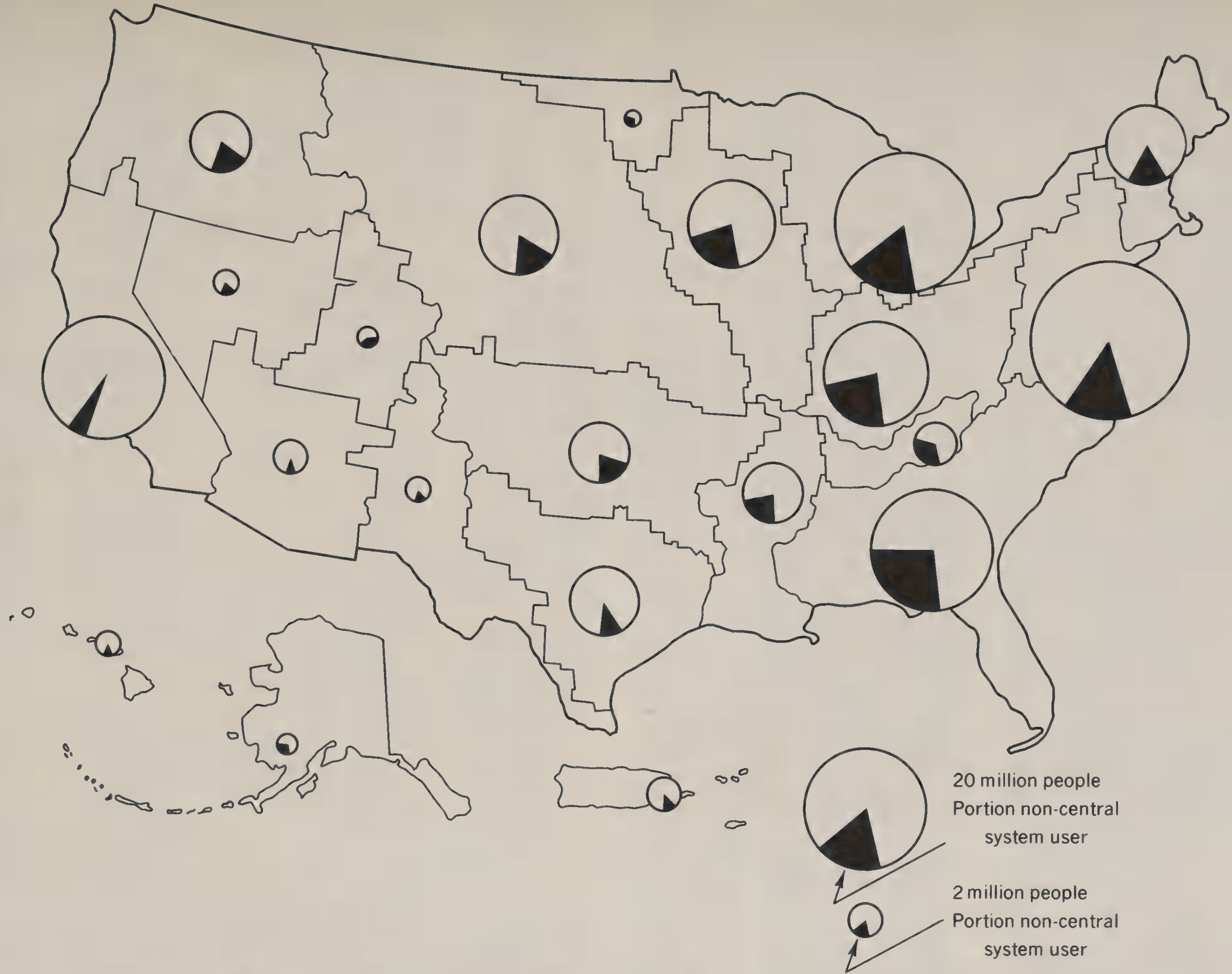


Figure 5C-8.--Population served by central and noncentral systems in 1975, by region. (Interagency Task Force on Irrigation Efficiencies, 1978)

Table 5C-3.--Population served by central and noncentral water systems

Type of system	1969	1975
	(millions of people)	
Central systems	166	179
Self-supplied systems	38	37
with pressure	30	31
without pressure	8	6
Total	204	216

Source: Second National Water Assessment (USDA, 1975c)

Water use in the contiguous United States, Hawaii, and the Caribbean water resources regions ranges from 8 gallons per capita per day (gpcd) to more than 400 gpcd (exclusive of agricultural and some industrial uses). Household use generally ranges from 8 to 80 gpcd. Lower use is found in houses without running water under pressure where an estimated average of 8 to 15 gpcd are carried into the house. Higher use occurs in houses with water under pressure, where 30 to 80 gpcd are used. Estimates of the daily per capita withdrawal and consumption by households on noncentral systems are:

Water under pressure	-withdrawal	66
	-consumption	40
No running water	-withdrawal	10
	-consumption	10

A modest increase in per capita household use is expected because of the continuing increase in appliances that use water; more water being applied to greenery; the growing number of households installing pressurized water supply systems for the first time; and the increasing number of areas changing over from noncentral to central systems.

Of the 60,000 public water supply systems, 52,000 serve communities of fewer than 3,000 people. Water resource studies have shown that water quantity and quality, or both, is a major problem in many small rural communities. Contaminant levels, particularly bacteriologic, exceed Safe Drinking Water Act standards. In small systems, samplings are sometimes not made and those that are made often show violations. Because of low funding levels, inadequate facilities, and lack of technical skills, many community water problems continue to persist.

Commercial.--The figures on per capita water use are generally much higher for central systems than self-supplied systems because, in addition to household use, they include commercial, municipal (firefighting, street cleaning, institutional irrigation) and, often, industrial use. Commercial withdrawals are estimated at 5.5 bgd and consumption at 1.1 bgd for "1975."

Manufacturing.--In "1975," manufacturing industries withdrew about 61 bgd (51 bgd freshwater and 10 bgd saline water). The freshwater was recycled about 2.2 times before 88 percent was returned to surface water sources.

The 300,000 manufacturing plants involved employ 20 million people and provide 27 percent of the total United States earnings.

Power Generation.--Steam-powered generation of electricity in "1975" withdrew almost 90 bgd--a fourth of all freshwater withdrawals--and consumed 1.4 bgd. The 90 bgd represent 94 percent of all withdrawals for energy production in the United States. Petroleum and coal refining and the mining of fuels (coal, natural gas, and oil) also use water. As coal-produced energy increases, so will the water used in its production. The areas where there will be great concern over water used for energy will be in the Missouri, Ohio, and Upper Colorado regions where there are large coal and oil shale deposits. Regulations to control water pollution will probably cause changes in cooling technology, which will reduce withdrawals of freshwater for thermal electric power.

Mining.--The mineral industries withdrew an average of 7 bgd of water in "1975," of which 2.2 bgd were consumed in mining metals (lead, zinc, manganese, gold, silver, copper, and molybdenum), nonmetals (lime, clay, barite, phosphate, rock salt, rock wool, pumice, cement, sand and gravel, and stone), and fuels (coal, oil shale, petroleum, natural gas, and natural gas liquids). Withdrawals for nonmetal mining were half the mining industries' total. But fuel mining accounted for nearly two-thirds of the industries' total consumption. More water consumption can be expected for mining in areas developing coal production and oil shale conversion.

Miscellaneous.--Water for fish hatcheries, public lands, and miscellaneous uses was withdrawn at an average rate of 2 bgd, of which two-thirds was consumed.

Instream Requirements

Instream requirements are the surface water areas or amounts of flowing water needed within the surface water system. These waters fulfill a need without having to be withdrawn from the surface source. Because the same unit of water can supply several needs, the areas and the flows are not additive. For example, the same surface used by fishermen may also satisfy esthetic needs; the same flow used by hydropower or navigation may be used for fisheries or to satisfy compact and treaty requirements, or both.

Recreation.--Water-related outdoor recreation can be divided into two types--"water-dependent," which requires a substantial supply of accessible water, and "water-enhanced," which requires supporting activities. The location and types of these activities are shown in figures 5C-9 and 5C-10.

Only about one-fourth of the 85 million acres of surface water is accessible and usable for recreation. The other 64 million acres are now inaccessible, polluted, or otherwise restricted from recreational use. As of 1975, about 8 million more acres of water were needed for recreation. (USWRC, 1978e).

Water recreation can be improved by preserving the value of free-flowing streams, improving water quality, increasing recreation opportunities at reservoirs, providing public access, and maintaining instream flows. Water use for recreation is further discussed in chapter 6.

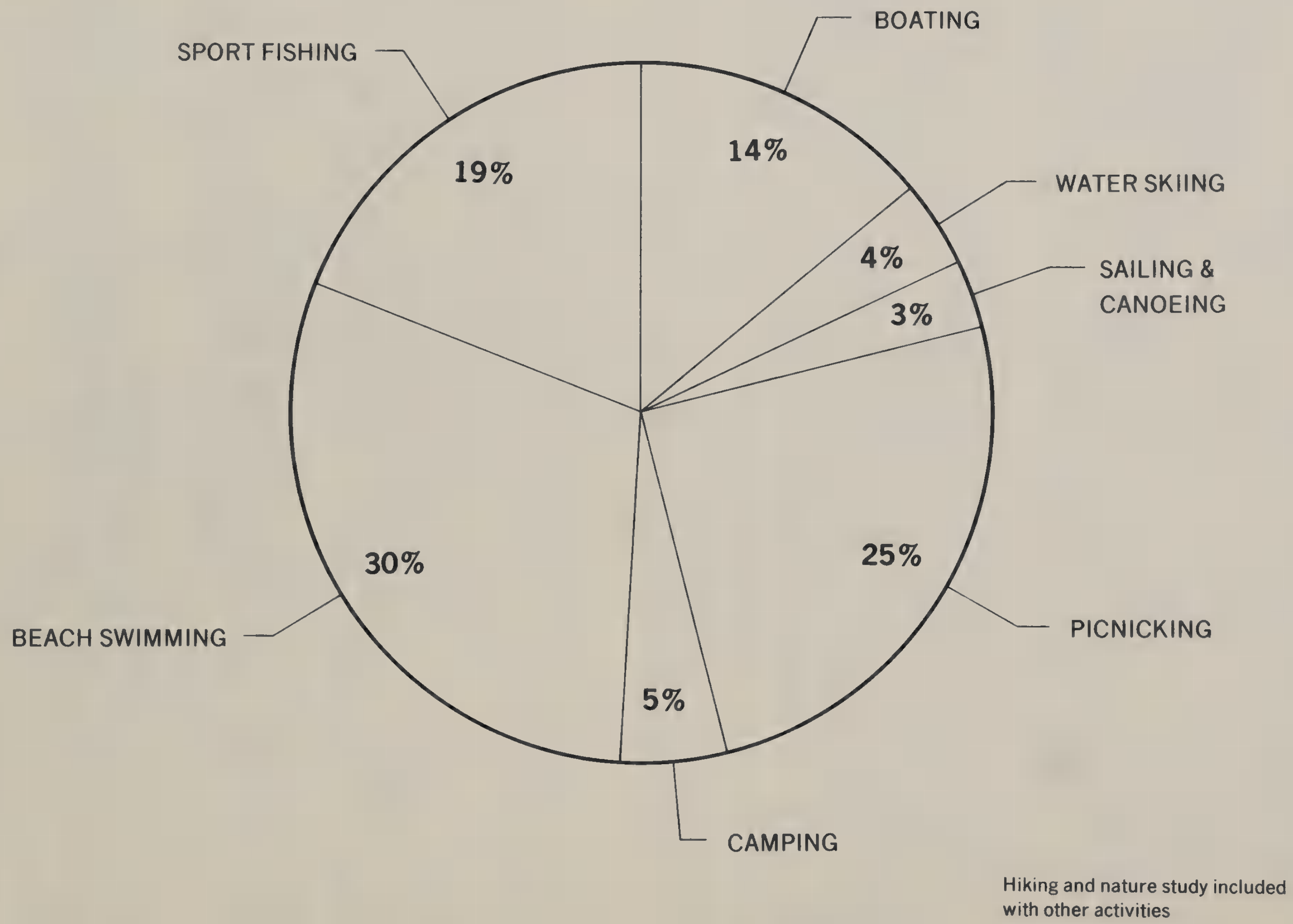


Figure 5C-9.--Types of water-related outdoor recreation activity occasions. (U.S. Water Resources Council, 1978e)

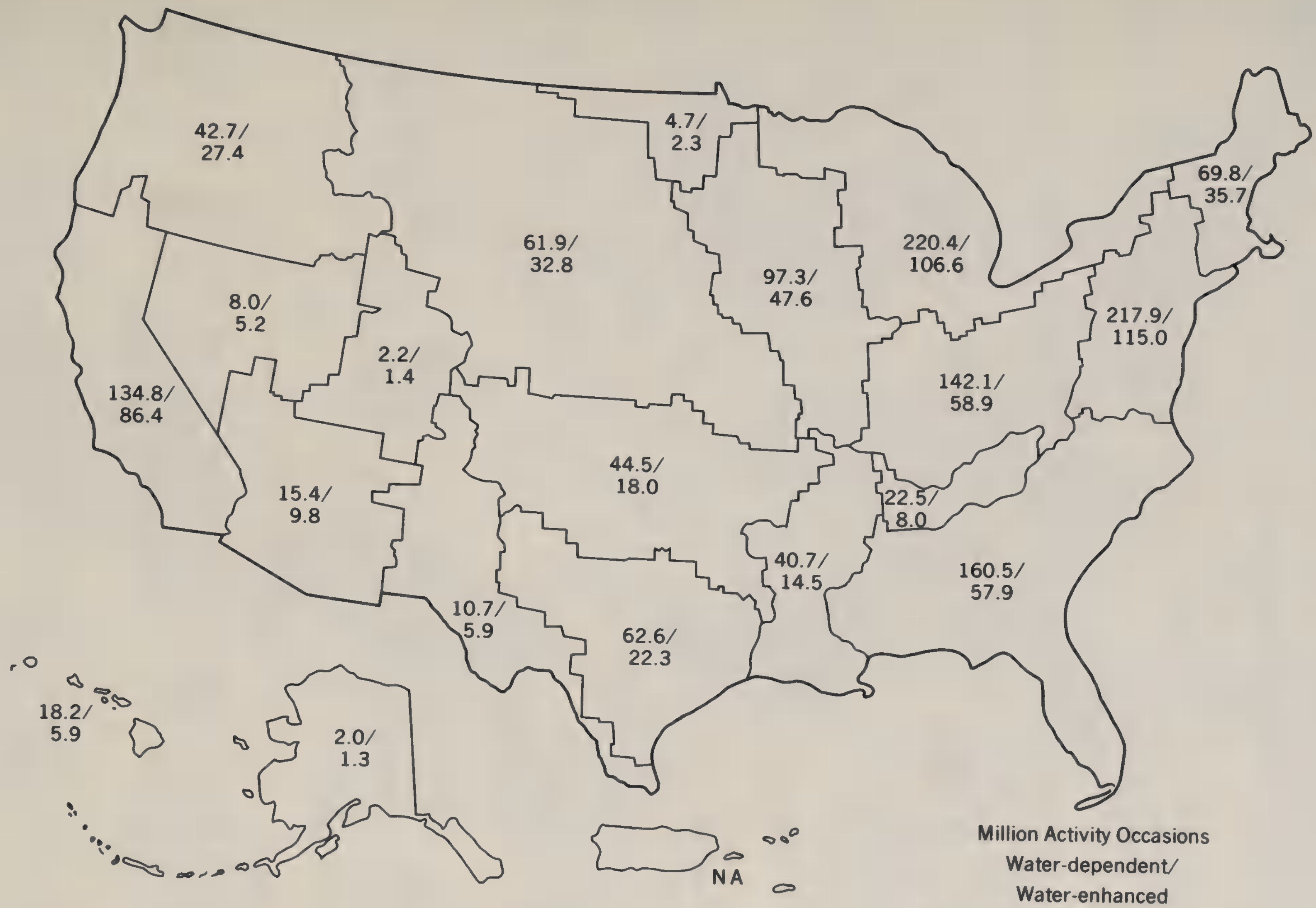


Figure 5C-10.--Water-related outdoor recreation activity occasions, "1975." (U.S. Water Resources Council, 1978e)

Fish and Wildlife--Sufficient flow regimes are needed to support the habitat of aquatic life forms. The estimates presented can only be considered approximations of the flows desired; they will generally exceed minimum fish and wildlife and other instream flow requirements. The U.S. Fish and Wildlife Service prepared these instream flow approximations (IFA) to show optimal conditions for fish and wildlife habitat. (See figure 5C-11).

The estimates can, at best, only indicate requirements in the stream reach near the outflow points; such estimates give little indication of the situation in the entire region. Water use for fish and wildlife is further discussed in chapter 6.

Hydropower.--Hydroelectric power plants produce power without consuming fuel and without polluting water and air. They capture energy by releasing water. Hydroelectric generation supplied 0.3 million gigawatts in "1975"--about 15 percent of the electric power generated and 5 percent of our total energy production. Hydroelectricity provides base loads in the Pacific Northwest where 46 percent of the hydropower generation occurs. It generally provides only peak load in the rest of the Nation. Because of low operating costs and advances in low-head flow generation and rewinding generators, there is renewed interest in the potential of hydroelectric power generation.

Navigation.--More than 25,000 miles of navigable waterways are used to transport commodities. Domestic waterborne traffic increased from 829 million tons in 1965 to 1,000 million in 1974. Domestic waterborne commerce was 16 percent of the net tons carried commercially and about 25 percent of the total freight measured in ton-miles--a slight decline from the percentage in 1965. The instream flow required for navigation depends on the size and depth of the channel and the number and operation of the locks. Even though 50 percent more waterborne freight is expected by the turn of the century, water supplies for navigation should be adequate.

Preservation.--Certain natural or historical areas require maintenance of surface flows, ground water levels, and natural high water quality. In some locations, minimum water flow is needed to meet commitments in treaties and compacts, to meet local or state health standards, and to support established esthetic values.

Water Supply and Requirements

Analyzing how water supplies are affected by use provides information on the adequacy of supplies, competing uses, and conditions that cause water shortages. The relationships between supplies and requirements are shown in figure 5C-12.

Table 5C-4 shows data on water supplies and use by region for an average year. The Nation's water supplies appear to be sufficient to meet water requirements. However, averages at the national or even at the regional level tend to obscure imbalances in water supplies and requirements at the subregional and local levels. In addition, characterizing only the normal or average condition negates the existence of abnormal or variable conditions.

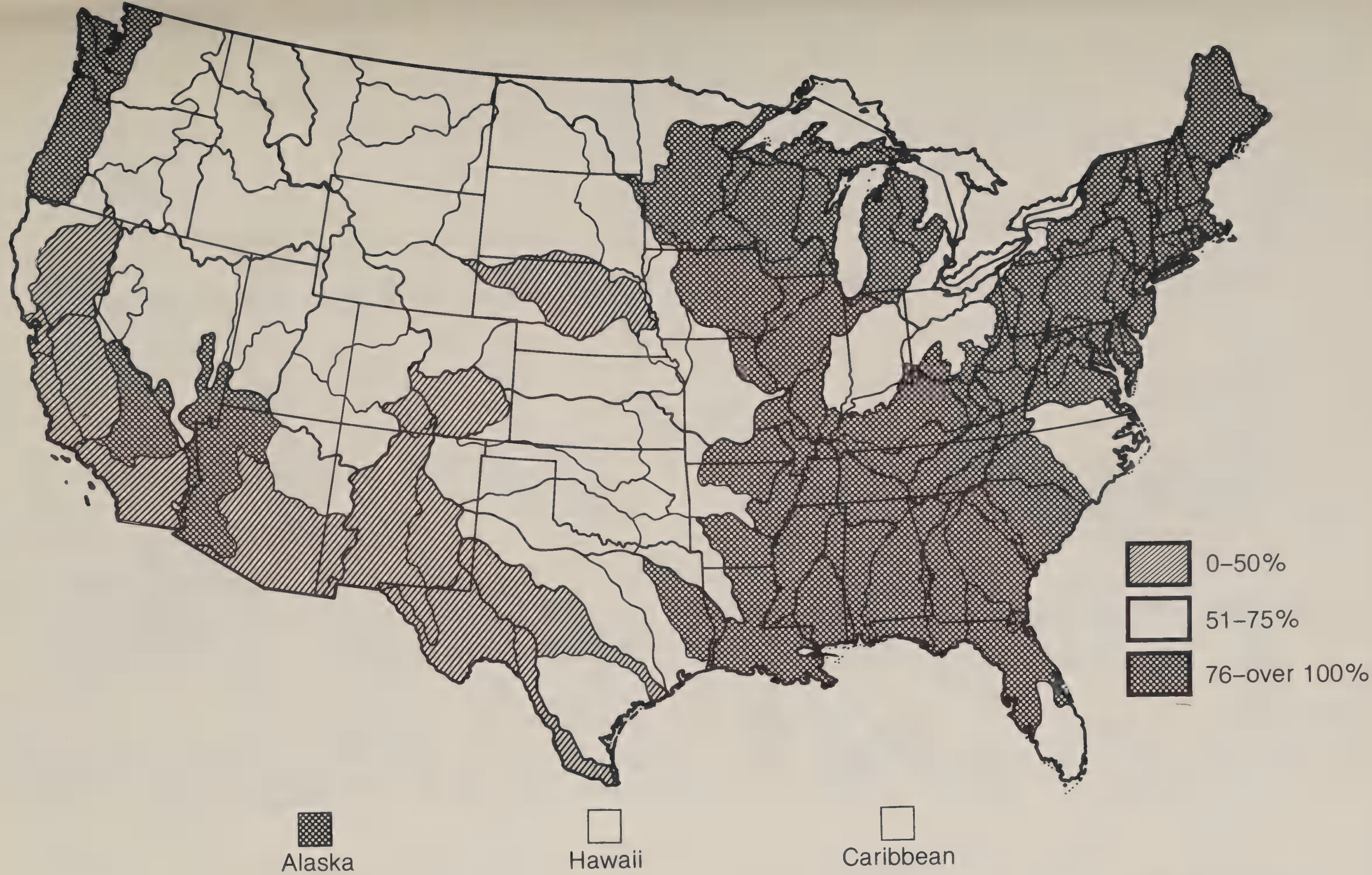


Figure 5C-11.--Instream flow approximations (IFA) for fish and wildlife as a percentage of total average monthly streamflow. (U.S. Water Resources Council, 1978e)

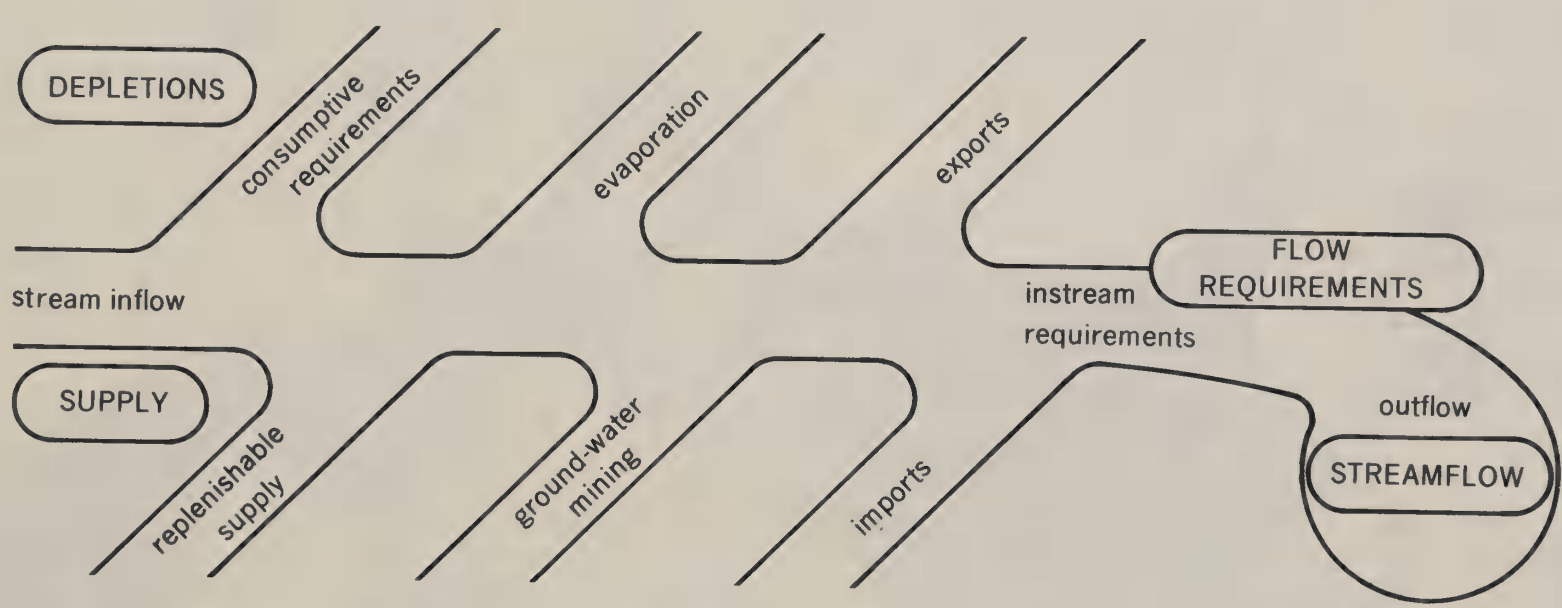


Figure 5C-12.--Schematic diagram of the water supply/requirement balance. (U.S. Water Resources Council, 1978e)

Table 5C-4.--Water supply and use

Water data	1975 average annual water data by region (expressed in mgd)							
	New England	Mid-Atlantic	South Atlantic-Gulf	Great Lakes	Ohio	Tennessee	Upper Mississippi	Lower Mississippi
Instream requirements								
Fish & wildlife (IFA) 1/	69,001	68,840	188,655	63,951	160,520	38,480	110,750	359,033
Navigation	0	0	21,630	0	410	16,100	34,880	119,500
Treaties and compacts	0	1,131	0	0	0	0	0	0
Flow requirements	69,001	68,840	188,655	63,951	160,520	38,480	110,750	359,033
Offstream requirements								
Irrigation	25	196	2,752	114	37	11	153	3,065
Livestock	18	68	134	85	113	27	230	44
Steam-electric	21	103	153	175	324	42	129	54
Manufacturing	192	607	611	1,474	817	147	240	314
Domestic	164	705	880	476	349	59	282	294
Commercial	48	91	118	113	62	11	63	49
Minerals	11	70	214	155	91	15	46	206
Other	2	3	5	6	5	1	2	1
Consumptive requirements	481	1,843	4,867	2,598	1,798	313	1,145	4,027
Exports	0	0	6	0	0	0	0	0
Evaporation	0	0		0	0	0	43	0
Total water depletions	481	1,843	4,873	2,598	1,798	313	1,188	4,027
Replenishable supply	78,661	80,522	232,544	75,262	138,998	41,113	76,024	75,015
Surface water 2/	78,026	77,893	227,434	74,074	137,155	40,842	73,658	70,589
Ground water pumped	635	2,629	5,110	1,188	1,843	271	2,366	4,426
Ground water mining	0	32	339	27	0	0	0	412
Imports	0	479	0	19	0	0	2,064	0
Total water supply	78,661	81,033	232,883	75,308	179,798 3/	41,113	122,188 4/	437,027 5/
Streamflow	78,180	79,190	228,010	72,710	178,000	40,800	121,000	433,000

Table 5C-4.--Water supply and use (continued)

Water data	1975 Average annual water data by region (expressed in mgd)								
	Souris-Red-Rainy	Missouri	Arkansas-White-Red	Texas-Gulf	Rio Grande	Upper & Lower Colorado	Great Basin	Pacific Northwest	California
Instream requirements									
Fish & wildlife (IFA) 1/	3,673	33,958	46,169	22,917	2,287	6,864	3,389 7/	214,004 7/	32,607 7/
Navigation	0	25,840	2,730	0	0	0	0	0	0
Treaties and compacts	0	42	188	0	54	1,340 6/	0	0	0
Flow requirements	3,673	33,958	46,169	22,917	2,287	6,864	3,389 7/	214,004 7/	32,607 7/
Offstream requirements									
Irrigation	37	14,214	7,048	9,347	3,886	6,220	3,225	11,026	24,282
Livestock	26	450	215	180	38	74	33	72	98
Steam-electric	1	68	89	99	18	102	3	13	25
Manufacturing	13	136	165	571	5	57	24	329	257
Domestic	25	262	279	413	139	224	131	210	1,279
Commercial	6	69	69	94	29	38	16	55	155
Minerals	3	111	173	555	103	198	28	18	183
Other	1	159	26	<1	22	122	319	190	362
Consumptive requirements	112	15,469	8,064	11,259	4,240	7,035	3,779	11,913	26,641
Exports	0	0	0	0	0	5,268	0	0	0
Evaporation	16	4,924	2,615	1,705	730	1,913	327	2,014	669
Total water depletions	128	20,393	10,679	12,964	4,970	14,216	4,106	13,927	27,310
Replenishable supply	6,138	61,525	67,694	35,626	5,309	13,351	5,976	268,523	68,050
Surface water 2/	6,052	53,675	64,305	33,982	3,631	10,632	5,143	261,802	51,087
Ground water pumped	86	7,850	3,389	1,644	1,678	2,719	833	6,721	16,963
Ground water mining	0	2,557	5,457	5,578	657	2,415	591	627	2,197
Imports	0	411	128	30	234	0	101	47	4,438
Total water supply	6,138	64,493	73,279	41,234	6,200	15,766	6,668	269,197	74,685
Streamflow	6,010	44,100	62,600	28,270	1,230	1,550	2,562 7/	255,270	47,375

Table 5C-4.--Water supply and use (continued)

Water data	1975 average annual water data (expressed in mgd)				
	Contiguous United States	Alaska	Hawaii	Caribbean	United States & Caribbean
Instream requirements					
Fish & wildlife (IFA) 1/	-	859,000	4,590	3,706	-
Navigation	-	0	0	0	-
Treaties and compacts	-	0	0	0	-
Flow requirements	8/	859,000	4,590	3,706	8/
Offstream requirements					
Irrigation	85,638	3	474	276	86,391
Livestock	1,905	<1	2	5	1,912
Steam-electric	1,419	0	0	0	1,419
Manufacturing	5,959	26	74	N/A	6,059
Domestic	6,171	6	44	49	6,270
Commercial	1,086	1	11	9	1,107
Minerals	2,180	12	0	4	2,196
Other	1,226	10	0	0	1,236
Consumptive requirements	105,584	58	605	343	106,590
Exports	0	0	0	0	0
Evaporation	14,956	0	1	0	14,957
Total water depletions	120,540	58	606	343	121,547
Replenishable supply	1,330,331	905,058	7,353	5,181	2,247,923
Surface water 2/	1,269,980	905,014	6,501	4,940	2,186,435
Ground water pumped	60,351	44	852	241	61,488
Ground water mining	20,889	0	0	13	20,902
Imports	2,677	0	0	0	2,677
Total water supply	1,353,897	905,058	7,353	5,194	2,271,502
Streamflow	1,233,357	905,000	6,747	4,851	2,149,955

Footnotes for table 5C-4

1/ Instream Flow Approximations (IFA) are quantitative expressions of judgmental estimates of the flow regimes needed to support aquatic life and outdoor recreation.

2/ Surface water supply includes water that has infiltrated to the saturated zone and reappears as surface water, e.g. seepage and springs.

3/ Ohio region total water supply includes inflow from the Tennessee region (40,800 mgd).

4/ Upper Mississippi region total water supply includes inflow from the Missouri region (44,100 mgd).

5/ Lower Mississippi region total water supply includes inflow from the Ohio, Upper Mississippi, and Arkansas-White-Red regions (361,600 mgd).

6/ Quantity does not include 6,700 mgd that the Upper Colorado States are obligated to release to Lower Colorado States.

7/ Quantities include flows in closed basins that go into dead lakes and/or playas.

8/ Instream flow requirements are not aggregated for the contiguous United States or the United States and the Caribbean.

Explanatory notes for table 5C-4

Instream requirements are estimates of the quantities of water needed within the surface water system--streams, etc.

Flow requirements are the largest instream requirement--generally the instream flow approximation (IFA).

Offstream requirements are the quantities of water needed for activities outside of the surface water system. This water is withdrawn from a surface or ground supply source and moved to the location of the activity. From there, the water is returned to the supply source or is consumed -- lost to the region's hydrologic system, most is returned to the atmosphere. The table shows the amount of water consumed by each different activity and the total consumptive requirements for all activities.

Exports are net transports of water from a region. Imports are net transports to a region.

Evaporation is water loss from manmade pond and reservoir surfaces that exceeds precipitation.

Replenishable supply is runoff, some recharges ground water supplies and some replenishes surface supplies. It would

Ground water mining occurs wherever withdrawals from ground water exceed recharge.

Total water supply is the inflow from upstream areas, replenishable surface and ground water, mined ground water, and imports from other regions.

Total water depletions are the sums of water consumed, exports, and evaporation.

Streamflow is the measure of water quantities at a hydrologic region's outflow point(s). It is the balance of the region's total water supply remaining after total water depletions.

Nationwide, 5.4 percent of the replenishable water supply is depleted. The percentage depleted in the humid regions is less than the national average, but in the arid regions this percentage is so high that it approaches the total replenishable supply. Figure 5C-13 shows subregions where water depletions are very large or will be before the turn of the century. Off-stream uses deplete the Lower Colorado and Rio Grande so much that they threaten the survival habitat of most aquatic life; the Great Basin's base flow may not sustain good survival habitat.

Streamflow that exceeds flow requirements creates surplus water. Conversely, water deficits occur when streamflow is not large enough to meet flow requirements.

When flow requirements exceed outflows there is a deficient supply of water for meeting both offstream requirements and optimum instream flows for fish and wildlife. Even in an average year, deficiencies occur in the Colorado, Rio Grande, and Great Basin regions. During dry years--an average of every 2 to 10 years when offstream requirements increase and flows are abnormally low--the instream supplies do not meet flow requirements. These deficiencies occur in every region except Hawaii. Figure 5C-14 shows inadequate streamflow by subregions.

Monthly variations in supply and site-specific demands compound water supply problems. Both offstream and instream demands for water resources are increasing, and competition for water will continue to become even keener. There are water supply problems in nearly every subregion in the United States.

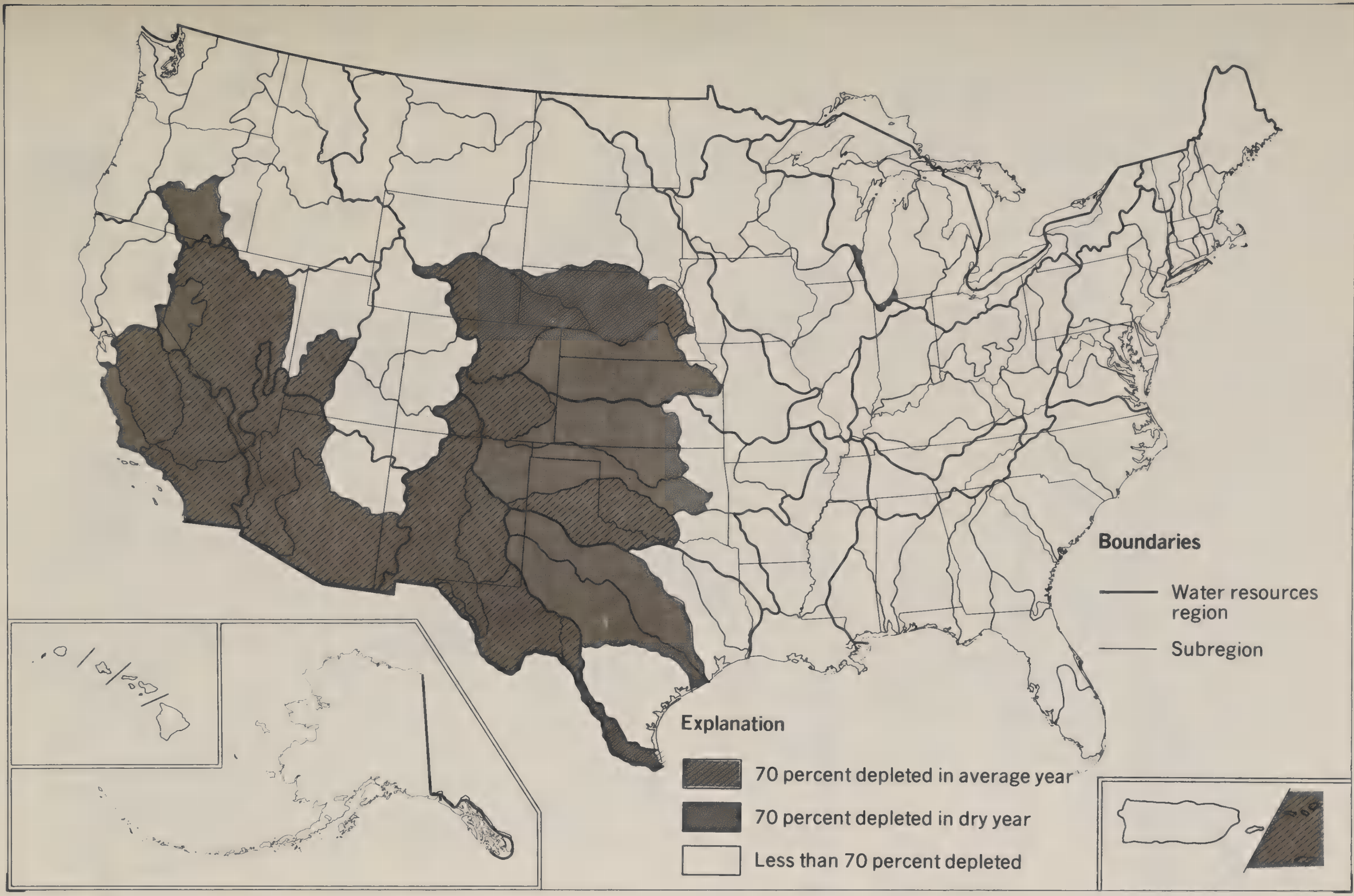


Figure 5C-13.--Water depletion areas. (U.S. Water Resources Council, 1978e)

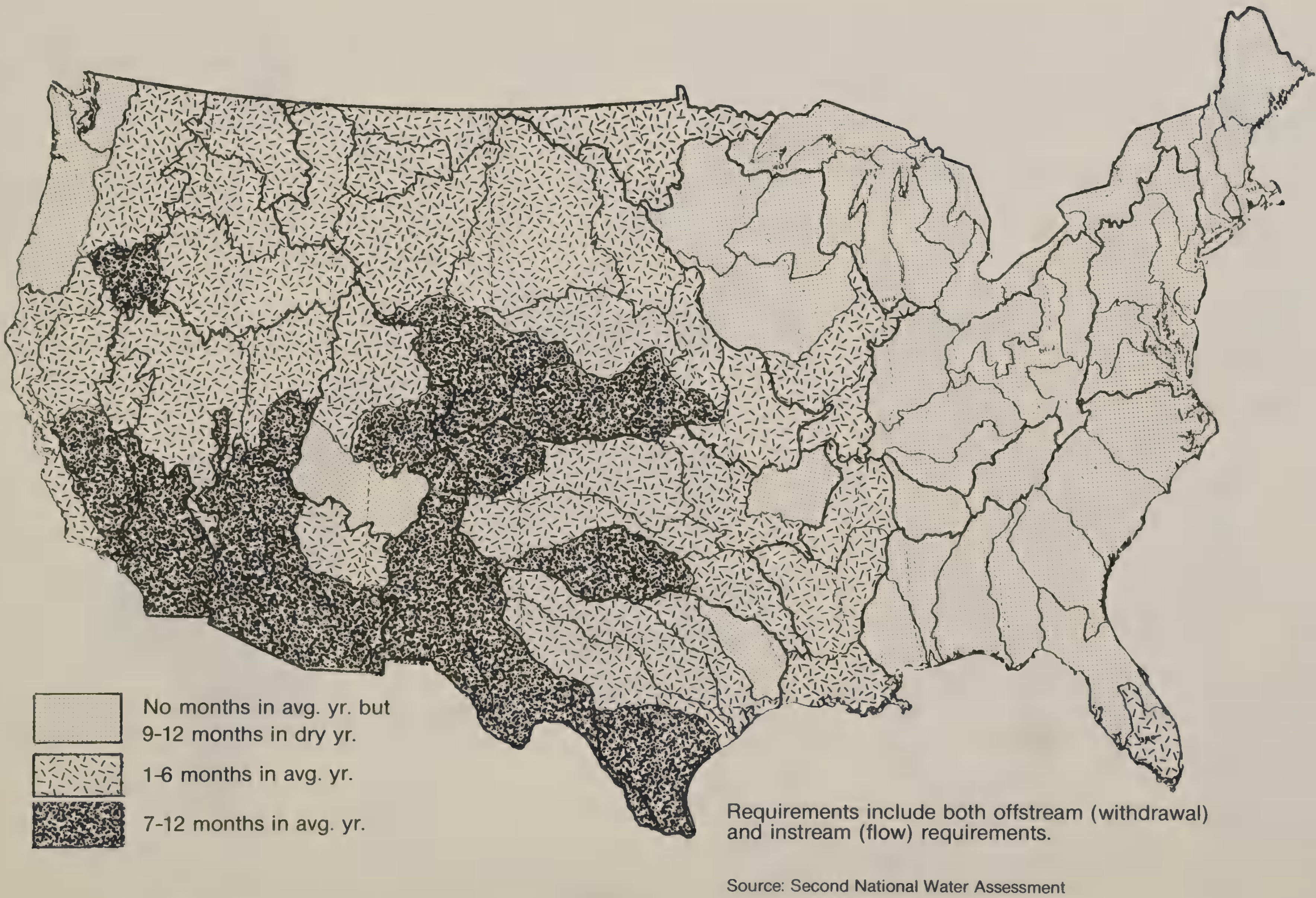


Figure 5C-14.--Number of months water requirements exceed supplies.

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Chapter 6 - Related Resources

Section A-Introduction

Odum (1971) states that "the true aim of conservation is twofold: (1) to insure the preservation of a quality environment that considers esthetic and recreational as well as product needs and (2) to insure a continuous yield of useful plants, animals, and materials by establishing a balanced cycle of harvest and renewal." (See references for section B.) Base resource products from cropland, pastureland, rangeland, native pastureland, and forest land provide the bulk of man's needs. However, there are "related resources" that are equally important because they are essential to "the preservation of a quality environment that considers esthetic and recreational needs."

The status, condition, and trend of each of the related resources--wetlands, riparian vegetation, wildlife habitat, windbreaks, recreation, and organic waste--affect base resource production as well as other related resources. These related resources are, in turn, affected by the status, condition, and trend of the land uses that provide base resource products. The importance of these interrelationships is apparent. Eliminating all windbreaks in the Great Plains, for example, would adversely affect cropland, wildlife habitat, and visual esthetics. Similarly, draining a significant portion of the 41.5 million acres of wetlands and utilizing it to supply base resource products would significantly affect riparian vegetation, wildlife habitat, and recreation.

Section B-Wetlands

Status

The original supply of wetlands was never inventoried. Circular 39, Wetlands of the United States (Shaw and Fredine, 1956), is the source for the following account of historic wetland inventories.

The 1906 Census of Drainage listed wetlands that could probably be easily reclaimed. The Census estimated at the time that 79 million acres of swamp and inundated land could be made suitable for profitable agriculture. It classified the total acreage according to agricultural capabilities under existing conditions as follows:

		Acres
1.	Permanently wet and not suitable for cultivation, even in favorable years, unless cleared or protected------------------------------------	52,700,000
2.	Wet pasture for livestock, though forage is often inferior----------------------------------	6,800,000
3.	Subject to periodic overflow by streams, but produces crops at times---------------------	14,700,000
4.	Too wet for profitable crops during above-normal rainfall periods, but usable during seasons of light or medium rainfall-------------	4,800,000

The 1923 Yearbook of Agriculture contains the second inventory of wetlands which was the most complete nationwide survey ever conducted and is still the basis of most estimates of reclaimable wetlands. This inventory showed 91,543,000 acres of wetland, of which 7,363,000 acres were listed as tidal marsh and the rest as inland marsh, swamp, and inundated land.

Two other estimates of wetland acreage appear in publications of the U.S. Department of Agriculture. From a drainage reconnaissance survey, technicians of the Soil Conservation Service estimated in 1940 that there were 97,332,000 acres of "wet, swampy, and overflow land outside organized drainage enterprises." A later estimate of such lands appears in Wooten (1953):

> Our country includes within its boundaries 125 million acres of undeveloped wet and swamplands which are subject to overflow. With proper drainage and protection, an estimated two-fifths of this area, or 50 million acres, would be physically suitable for crop or pasture use.

In 1956, Circular 39 indicated that only about 82 million acres of wetlands remained in the continental United States (Shaw and Fredine, 1956). It is apparent that wet soils and wetlands as inventoried in Circular 39 are not the same when viewed in terms of present concepts. Today, by comparison, about 270 million acres of nonfederal land consist of wet soils. Available

data indicate that about 104 million acres or 40 percent of the wet soils on nonfederal land are cropland (USDA, 1978). The other 166 million acres have not been drained or managed for cropland. Therefore, there are about 84 million acres more undrained wet soils in the United States than there are wetlands as defined in Circular 39 by Shaw and Fredine.

According to the 1977 SCS National Resource Inventories (USDA, 1978) there are 41.5 million acres of nonfederal land classified as wetland types 3-20. This inventory did not record the acres of wetland types 1 and 2. However, Circular 39 inventoried 33.7 million acres of wetland types 1 and 2 and 48.3 million acres of types 3 through 20 in 1954. If we assume the same rate of loss (14 percent) for wetland types 1 and 2 that has occurred for types 3 through 20 between 1954 and 1977, then it can be estimated that there were 29.0 million acres of types 1 and 2 in 1977. This estimate added to the 41.5 million acres of types 3 through 20 inventoried in 1977 gives a total estimated wetland area of 70.5 million acres.

The National Resource Inventories determined the distribution of wetlands by farm production regions. The Lake States lead the Nation with 12 million acres, followed by the Southeast with 10.3 million acres, and the Delta States with 6 million acres. More than two-thirds of wetland types 3-20 in the United States are in these three regions.

<u>Extent, Use, and Distribution of Wet Soils</u>.--There are about 270 million acres of wet soils in the United States. Cropland accounts for 104 million acres, pasture and range another 56 million acres, and forest and other land the remaining 110 million acres. Thus, about 61 percent of the wet soils that best qualify as wetland types 3-20 are undrained and are used for grazing, timber production, wildlife habitat, and other purposes. These figures are supported by forest surveys. Commercial wetland forests occur on sites subject to annual or periodic inundation, on stream and river bottoms, or on areas where the permanent water table is at or near the surface, as in bogs or swamps. Based largely on forest surveys, the acreage of commercial wetland forest types that normally occur on bottomlands and swamps is estimated at 82 million acres in the 48 contiguous states and Alaska. Nearly three-fourths of the acreage is east of the Rockies and two-thirds of the trees are deciduous species, including baldcypress and pondcypress.

<u>Wildlife</u>.--Wetlands are extremely productive habitat. Odum (1971) gave some indication of the high productivity of shallow lakes and wetlands compared with terrestrial and marine systems. He found that marshes compared favorably with the best managed moist terrestrial systems in terms of the primary production of plants. Although larger animals are high in the food chain, they constitute a small portion of the total biomass and it is the insects, birds, and small mammals that really show the richness of the food chains in wetlands. Sometimes the density of such animal life in marshes is overwhelming--as in the case of concentrations of nesting ibises and egrets. Other times they are a source of concern--nuisance insects or migratory blackbirds. But it is always obvious to an observer that marshes are a rich resource providing ideal habitat for many species of animals. They are unique islands of richness, often isolated in less productive or even sterile environments. They have been a focal point for adaptation by animals exploiting their resources of water, food, and cover.

In appraising the values of wetlands, primary emphasis is normally placed on waterfowl because of the great interest in the sport of waterfowling and because waterfowl populations are more affected by wetland losses than any other game species. Waterfowl depend on wetlands for food, nesting cover, brood habitat, protective cover, and loafing areas. Wetlands play an integral role in at least some portion of the life cycle of each waterfowl species. Resident game mammals (such as deer and bobcats) and migratory game birds not usually classified as waterfowl use wetland vegetation as protective cover. The value of marshes and swamps for furbearers such as muskrats, mink, beaver, raccoon, and otter is well documented. Among the wildlife associated with wetlands are 19 species of small game, 7 species of big game, 11 species of fur animals, and literally hundreds of species of nongame mammals, birds, amphibians, and reptiles. Fish and shellfish are known to use coastal and inland marshes and associated shallow water areas to a very significant extent.

Commercial Forest (Johnson, 1978).--The most extensive and economically important wetland forests are in two broad forest survey types--oak-gum-cypress and elm-ash-cottonwood. Both types are restricted to the eastern United States, but oak-gum-cypress is found mostly in the South, 29 million acres, and elm-ash-cottonwood mainly in the North, 22 million acres. Both types may grow under similar moisture regimes, but oak-gum-cypress is usually subject to more frequent and longer periods of inundation. There is considerable species variation within both types and each is a conglomerate of several management types recognized by the Society of American Foresters. Forest surveys define elm-ash-cottonwood as forest in which elm, ash, or cottonwood singly or in combination form a majority of the stocking. Oak-gum-cypress is forest in which tupelo, blackgum, sweetgum, oaks, or southern cypress singly or in combination form a plurality of the stocking. Common associates in the oak-gum-cypress type are cottonwood, willow, ash, elm, hackberry or sugarberry, and maple. Associates within the elm-ash-cottonwood type are willow, sycamore, beech, and maple.

From the Rocky Mountains westward, the acreage of wetland forests cannot be extracted from survey data. Species that grow on wetland sites also occur on upland sites, but data on the proportion of each are unavailable. Red alder, black cottonwood, cedar, willow, and ash are among the trees that commonly grow on wetland sites. Forested wetlands in the western United States have relatively little economic value compared to upland forests. Although there are commercial size trees of suitable species in these forests, there is scanty information on stand volume, growth, or commercial value.

Alaska has a vast acreage of wetland forest. There are approximately 18 million acres of bottomland spruce-poplar forests. The forest, which is usually predominantly white spruce with varying amounts of cottonwood or balsam poplar, occurs on nearly level flood plains and low river terraces. In the succession, cottonwood and balsam poplar are ultimately replaced by the white spruce. White spruce accounts for 81 percent of interior Alaska's sawtimber volume, or about 25 billion board feet.

Another major forest type, lowland spruce-hardwood, covers about 35 million acres in interior Alaska. It occurs in rolling basins and knolls in the lowlands. Small bays and muskegs are found in the depressions in these

lands. The type includes extensive pure stands of black spruce, which is a slowly growing species that seldom exceeds 8 inches diameter breast height (dbh) or 50 feet in height. After a fire, cones of black spruce open and spread abundant seed, so that black spruce quickly reforests burned areas. Tamarack is associated with black spruce in the wet lowlands, but it grows slowly and seldom gets larger than 6 inches dbh.

Because of its low productivity and the small maximum size of the trees, the lowland spruce-hardwood type of interior Alaska has little or no commercial value.

Hydrologic Values (Novitzki, 1978).--Wetlands can be classified hydrologically as surface water depressions, surface water slopes, ground water depressions, or ground water slope wetlands. Within each of these classes, several wetland types may occur that span the range of conditions from wet to dry.

Wetlands reduce flood peaks, increase streamflow in spring, and reduce baseflow in fall. Where wetlands make up 40 percent of the basin, flood peaks are reduced as much as 80 percent. In these areas streamflow is increased and decreased, respectively, by approximately 40 percent in spring and fall. Wetlands making up the first 5 percent of the basin have the greatest influence on streamflow characteristics. The destruction of wetland will have a greater hydrologic impact in basins that have little wetland area.

Wetlands also improve water quality. Sediment yields may be reduced by as much as 90 percent in basins that are 40 percent lake and wetland area. Wetlands in depressions retain in deposits all of the sediment entering them, but even sloping wetlands may retain through sorptive action as much as 80 percent of the sediment that enters them.

Nutrient Traps (Van der Valk et al., 1978).--Nonpoint nutrient loadings from agricultural land are highly variable and depend in part on both relative and absolute amounts of surface runoff and subsurface flow, which in turn depend on climate and soil variables. Nonpoint sources of nutrients from agricultural runoff also contribute to the poor water quality in many regions of the United States.

Seventeen studies found that wetlands improve water quality to some extent, i.e., all the wetlands trapped phosphorus (P), nitrogen (N), or both, at least seasonally (table 6B-1). All 16 studies that measured phosphorus indicate that wetlands remove phosphorus from water passing through them at least during the growing season and in many cases in all seasons. Nitrogen inputs and outputs from wetlands have been studied at 14 wetland sites. In 12 of the wetlands, nitrogen was removed at least seasonally, but 2 wetlands added nutrients or at least did not reduce the levels of nitrogen in the water. Although these studies varied greatly in intensity, there is a remarkable overall consistency to the data. This is even more surprising considering that the studies contain data: (1) from all four basic hydrologic types of wetlands (riverine, tidal, lacustrine, palustrine); (2) from temperate, subtropical, and tropical wetlands; (3) from wetlands dominated by both herbs (marshes) and trees (swamps); and (4) from three continents.

Table 6B-1.--Summary of published information on natural wetlands as nutrient (N or P) traps or sinks for polluted water (Novitski, 1978)

Wetland site	Wetland type	Sampling period	Nutrient trap N	Nutrient trap P
Chambura Papyrus Swamp, Uganda	Riverine	Spring	---	Yes
Sudd, Sudan	Riverine	All year	Yes	---
Olifantsvlei, South Africa	Riverine	Spring & winter	No	S 1/
Lillon, Sweden	Riverine	All year	S	S
Santee Swamp, South Carolina	Riverine	Winter & spring	Maybe	Yes
Theresa Marsh, Wisconsin	Riverine	All year	S	S
Tinicum Marsh, Pennsylvania	Tidal	Summer	Yes	Yes
Hamilton Marsh, New Jersey	Tidal	All year	S	S
Balaton Lake, Hungary	Lacustrine	Summer	Yes	Yes
Masurian lakes, Poland	Lacustrine	Summer	Yes	Yes
Lake Wingra Marsh, Wisconsin	Lacustrine	All year	---	Yes
Horicon Marsh, Wisconsin	Palustrine	All year	Yes	S
Waldo Cypress Stand, Florida	Palustrine	All year	---	Yes
Wildwood Marsh-Swamp Florida	Palustrine	All year	Yes	Yes
Chandler Slough, Florida	Palustrine	All year	No	Yes
Brillion Marsh, Wisconsin	Palustrine	All year	Yes	Yes
Eagle Lake, Iowa	Palustrine	All year	Yes	Yes

1/ S = seasonally, i.e., wetland acts as an N or P trap only part of the year.

The efficiency of wetlands in removing nitrogen and phosphorus naturally varies from site to site. Each of these studies describes a particular wetland with its own unique hydrological regime, water chemistry, vegetation, basin morphometry, substrate, retention time, and loading of nitrogen and phosphorus.

Removal of Suspended Sediments (Boto, 1978).--One of the major functions performed by wetlands is the removal of suspended sediment from water. As water moves through wetlands, it moves more by sheet flow than channel flow resulting in a decrease in velocity. The presence of vegetation then causes suspended particles to settle. The effect of salt water in wetlands where there is estuarine mixing further enhances sediment removal by flocculation of clay particles. The transfer of the suspended sediment and associated dissolved materials from the water column to the land surface has important consequences both for the quality of the water and the properties and functions of the wetland. In areas where the land surface is subsiding, sediment removal from the water is essential for maintaining the marsh surface. With the recent increases in the amount of toxic substances in the water reaching wetlands, the wetlands are serving more than in the past as a sink for materials with known toxic effects on biota. The long term consequences of this phenomenon are poorly understood and deserve study.

Trends

Wetland Loss.--Ladd (1978) gave the following account of the trends in wetlands loss.

> "There are no precise figures on the extent of the total loss of wetlands in the United States; however, there are scattered data by state, region, and other geographical areas. There have been extensive habitat losses in the Prairie Pothole states where some 35,000 acres of wetlands were drained annually during the late 1960's--a yearly loss of nearly 2 percent. This trend continues today, perhaps at an even faster pace. Western Minnesota, for example, experienced a 40 percent decline in its wetland area from 1964 to 1974. More than 95 percent of its prairie potholes have been lost. Other midwestern states have experienced equally dramatic losses of wetlands.
>
> "The coastal zones of the United States support tremendous numbers of waterfowl during the migratory and winter seasons in every flyway. During the 1950's and 1960's, dredging and filling destroyed about 30,000 acres of coastal habitat annually. By 1970, three-quarters of all coastal habitat having significant wildlife value had been "moderately" to "severely" degraded.
>
> "The lower Mississippi River bottomlands--or Delta--from Missouri to Louisiana is another traditional waterfowl area where there have been dramatic changes in land use. These lands are wooded swamps and seasonally flooded hardwood forest that form excellent winter habitat for mallards and

> production habitat for wood ducks. By 1970, two-thirds of the original 24 million acres of forested wetlands in the Delta region had been cleared and converted to crop production. Another 250,000 acres or more are lost every year. By the turn of the century, we expect that the only natural wetlands remaining in the Delta will be public lands.
>
> "California's Central Valley, where two-thirds of all Pacific Flyway waterfowl winter, is another area that has experienced tremendous habitat losses. About 90 percent of the natural waterfowl habitat in the Valley has been lost. Most of the remnants are intensively managed by hunting clubs or state and federal wildlife agencies."

For this report the trends in wetland loss have been estimated as described below. If the 1954 figure of 82 million acres of wetlands in the 48 conterminous states is compared with the 1977 estimate of 70.5 million acres, the average annual loss over the 23-year period is 500,000 acres.

A number of factors have contributed to the loss of wetlands in the United States. Urban and industrial development, waterway construction, highways, impoundments, and drainage for agricultural purposes have all taken their toll. Although there are no recent inventories on the amount of wetland lost to cropland, there are some data on the conversion of uncropped wet soils to cropland (table 6B-2). Between 1967 and 1975, approximately 3.8 million acres of wet soils were converted to cropland in the Corn Belt and Delta States. These are the regions where most of this conversion has taken place. Not all wet soils are classified as wetlands, but much of the acreage that was converted is in wetlands types 1 and 2.

Wetland Aquisition and Preservation.--The national effort to conserve wetlands is based on public ownership and rental of wetlands that are properly managed. These wetlands are designed to protect and enhance key areas used by waterfowl.

The Federal Waterfowl Refuge System encompasses almost 30 million acres of which about 11.4 million acres provide substantial benefits for waterfowl (Bellrose, 1978). An additional 1.6 million acres of wetlands are protected under the wetlands aquisition program administered by the Fish and Wildlife Service. The Waterbank Program of the Department of Agriculture has wetland protection and management contracts on 480,048 acres of private land. In addition, wetlands under state control amount to about 5.1 million acres. Altogether, more than 19 million acres of wetland and adjacent upland areas are under state or federal control or contract.

Table 6B-2.--Changes in cropland acres for land capability classes having wet soils in two major farm production regions, 1967 to 1975

Crop production region	Capability class and subclass	1967 1/ Cropland	1975 2/ Cropland	Change in cropland
			(million acres)	
Delta States---	IIw	4.2	4.8	0.6
	IIIw through VIIIw	9.2	9.9	0.7
Corn Belt------	IIw	26.7	27.6	0.9
	IIIw through VIIIw	9.6	8.5	-1.1

1/ Based on Conservation Needs Inventory (USDA, 1967).
2/ Based on Potential Cropland Study (USDA, 1975).

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Section C-Riparian Vegetation

Status

Riparian vegetation occurs in plant communities along streams or rivers from high mountain to low desert elevations. The level of soil moisture seldom limits the establishment and growth of riparian vegetation, at least for perennials, but surface water may be lacking at times in marginal areas. The wide array of habitat formed by perennial riparian vegetation sustains an equally diverse array of animal species.

There are no comprehensive data covering the extent of riparian habitat in the United States. A standard definition or classification system for riparian habitat has not been developed. However, several site-specific classification systems have been formulated.

According to a report by the Corps of Engineers (1969), there are 3 million miles of streams and rivers in the contiguous 48 states. There are 175 million acres of flood plains associated with these streams and rivers of which 154 million are used for the production of food and fiber. A percentage breakdown (USDA, 1978) of the 175 million acres is:

5%----------------	irrigated cropland
22%----------------	nonirrigated cropland
11%----------------	native pasture and pastureland
20%----------------	rangeland
30%----------------	forest land
12%----------------	other land

Of the 175 million acres of flood plains, 54 million acres are prime farmland. Depending on the definition and classification system used, some or all of the flood plain forest could be identified as riparian habitat.

Riparian vegetation in the eastern United States is discussed in the wetlands section.

Riparian vegetation in western arid and semiarid environments provides unique plant and animal habitat. The density of breeding birds is likely to be high with as many as 1,000 pairs or more per 100 acres (Carothers and Johnson, 1975). Though riparian communities are often small and confined, they are highly productive and support the greatest variety of birds (and probably other vertebrates) in arid and semiarid regions.

The total acreage covered by riparian vegetation in the arid and semiarid western states is relatively small. The riparian area in Arizona is some 279,600 acres (Babcock, 1968), including 100,700 acres along the Gila River. The areas within New Mexico may be comparable, or slightly larger if the substantial areas of mesquite, Fremont cottonwood, and saltcedar along the main stem of the Rio Grande are included. The importance of this streamside habitat to fish and wildlife, however, is generally unequaled by

any other type of habitat (Carothers, 1977). Estimates indicate that 80 percent of the breeding birds and 75 percent of the fish species in the Southwest depend on riparian ecosystems associated with flood plains.

Condition and Trend

The settlement patterns of native American Indians show the initial use of riparian habitat. The Indians first settled the river valleys because they needed water for themselves and, later on, for livestock and irrigating crops in some areas. This pattern of use accelerated greatly as settlers moved into the river valleys. Prospectors, farmers, townsmen, and ranchers all found uses for the water and its associated vegetation.

These settlers cleared large expanses of native vegetation, using some for building materials. For the most part, however, they did not view the riparian woodlands as a valuable resource. They cleared them so the alluvial bottoms could be used for crops, livestock, and building. Eventually, farming and ranching became thriving concerns and, in the West, river water was channeled into irrigation canals. Responding to increasing water needs or damaging floods, or in simple attempts to increase the yield of the land, western landowners finally constructed dams that inundated and destroyed even more riparian woodland and free-flowing streams and rivers.

By the late 1920's, America had shifted from a rural to a predominantly urban Nation. The beginning of an urban-industrial civilization in the arid and semiarid West required many technological advances to develop verdant oases where only parched deserts once prevailed. As population centers expanded rapidly, water management and salvage became very critical and they remain so today.

As recently as the late 1960's, water and flood control agencies were still actually removing belts of native riparian woodland along the river valleys of certain western states. The objectives of these phreatophyte control and channelization projects were (1) to decrease the amount of water lost to the atmosphere through evapotranspiration by streamside vegetation and (2) to decrease flooding caused by the temporary damming of channels by vegetation. The questions of how much water is gained and to what degree floods are prevented by phreatophyte control and channelization are still unresolved. It is evident, however, that these practices in most instances have major unfavorable effects on riparian wildlife habitat (Lacey et al., 1975; Paylor, 1974).

Perhaps the most insidious threat to riparian habitat today is improper grazing by domestic livestock. Many grazed riparian areas appear to be in good condition. A closer examination reveals, however, that while the mature vegetation is approaching senescence, heavy grazing has prevented the establishment of seedlings. It is a major concern that when many of these mature stands of trees die of natural causes, there will be no young forms to take their place. Heavy grazing can and does result in vegetative communities that are of equal age and do not reproduce.

Livestock normally concentrate in riparian areas because of the presence of succulent forage, shade, and water. Improper livestock grazing has reduced the productivity of fish and wildlife habitat, degraded water quality, and influenced flow fluctuations. Livestock grazing has been identified in numerous studies of riparian zones as the major factor causing serious reductions in habitat quality (Interagency Wildlife Committee, 1979).

Williams (1978) states that the width of the channel of the South Platte River in Colorado and Nebraska has been reduced by 89 percent in the last 100 years. This reduction can be easily attributed to encroachment on the riparian habitat by other uses.

The influence of riparian habitat on wildlife is not limited to animal species that live near streamside vegetation. A riparian area influences the population densities of birds in adjacent habitat in both river valleys and mountain areas. When a riparian habitat is removed or severely manipulated, not only are the riparian species of that area adversely affected, but the wildlife productivity of adjacent habitat is also depressed. The actual width of the zone of influence that riparian habitat has on wildlife productivity in adjacent habitat may, for some animal species, extend well beyond the edge of the streamside vegetation. Thus, the loss of riparian vegetation adversely affects not only wildlife that depend primarily on the riparian zone, but also wildlife that use riparian vegetation as a habitat element in some stage of their life history.

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Section D-Fish Habitat

The total water area in the United States, including the Great Lakes and the streams, rivers, and estuaries in the contiguous states, is 108 million acres or about 5 percent of the Nation's total area (USDA, 1978a). Most of these waters provide some type of fish habitat. Approximately 4,561,000 acres of aquatic habitat are in streams less than one-eighth mile wide. This category includes practically all cold water streams and many cool and warm water streams. Water bodies of less than 2 acres cover a total of 1,220,000 acres. Many farm ponds, prairie potholes, and other small natural lakes fall within this category. Water bodies between 2 and 40 acres account for another 3,549,000 acres of water. Included in this acreage are most small flood water retarding watershed structures, some farm ponds, natural lakes, and medium-sized publicly owned water bodies. The rest of the acreage is made up of large inland reservoirs; large inland rivers (more than one-eighth mile wide), the Great Lakes and other natural lakes; bays such as the Chesapeake, Delaware, and San Francisco; sounds such as Long Island and Puget; and the Atlantic, Gulf, and Pacific coastal waters.

Condition

Lakes and Reservoirs.--The area of existing reservoirs now exceeds 11,795,000 acres (USWRC, 1978). Virtually all reservoirs and shorelines are owned by the public and open to them. Most of the reservoirs are relatively productive and heavily used (Woodbury, 1967).

A 1967 study of the fish in 127 reservoirs indicated that the average annual standing crop was 186 pounds per acre; the mean sport fishing harvest was 22.6 pounds per acre; and the mean annual harvest of commercial species was 10.2 pounds per acre (Jenkins, 1967).

Natural lakes in glaciated regions and alluvial flood plains constitute a significant national fishery resource. Glacial lakes are the single largest category of natural lakes in the United States. Formed in the wake of glacial recession, they include a variety of morphological types. Most are relatively low in basic fertility because of their short growing seasons and the unproductive soils and bedrock underlying them and their watersheds.

The wave and current activities of streams have created numerous lake basins in river flood plains. The mature flood plains of the Mississippi and other large rivers contain hundreds of oxbow lakes occupying abandoned river channels. The lower ends of many of the oxbows are blocked by sediments deposited by the parent stream as the meanders were cut off. Since most of these lakes occur in fertile alluvial soils, fish production is generally good or potentially good. In the lower Mississippi Valley many of the natural lakes have been cut off from river overflows and, without periodic flushing, they have built up concentrations of pesticides and unbalanced fish populations. Lakes receiving periodic flooding from other streams or fresh-water sources generally maintain better fish populations.

There is more sport fishing in lakes and reservoirs than in any other types of water bodies. Sixty-five percent of warm water fishing and 48 percent of all cold water angling take place in lakes and reservoirs.

Farm Ponds.--Farm ponds provide several benefits, i.e., water for livestock, wildlife habitat, reduced soil erosion, and fish habitat. According to a recent SCS survey (USDA, 1979), there are 2,497,983 farm ponds within the United States that contain 2,648,059 acres of water (table 6D-1). Pond construction was begun in the colonial period to provide power for operating water mills and to furnish fish. By 1850, ponds were present in small numbers throughout the United States, but rapid expansion in construction did not come until after 1940 (Swingle, 1970).

Farm ponds constitute a major fishery resource. The number of ponds in the United States has increased from approximately 20,000 in 1936 to nearly 2.5 million today. Intensive research on pond management, begun in the 1930's, furnished the basis for efficient fish production through stocking, fertilization, and other management techniques. When ponds are properly planned, farmers can control the water depth, water quality, balance of the fish population, and other factors involved in fish management to provide production. In the Southeast, where farm pond management is most widespread, pond management for fish has multiplied the per acre catch in sport fishing about 10 times, from 15 to 20 pounds per acre to 175 pounds per acre. Fertilization, which enriches the pond ecosystem and stimulates higher fish production, is the primary factor bringing about this increase.

According to the 1975 National Survey of Hunting, Fishing, and Wildlife-Associated Recreation, farm ponds account for approximately 11 percent of the total warm water angling. According to the SCS survey, 69 percent of the farm ponds have been stocked for some type of fishing or home use. Many other farm ponds inventoried in the SCS survey, however, were not designed for fish production or occur in arid or semiarid areas where lack of a dependable water supply makes fish management unfeasible.

Although the potential is high for fish production in farm ponds, the cost of fertilization, direct feeding, chemical controls, and supplemental stocking prohibits widespread fish management. In addition, few owners of private ponds have the incentive to spend a lot of time or money to achieve high levels of fish production. Only 44 percent of the owners of recently stocked ponds in Illinois followed a recommended management strategy for farm pond management. A 1959 study indicated that only 20 percent of the Nation's farm ponds supported fish populations that met management objectives.

Farm ponds can achieve exceptional fish production if they are managed intensely. Aquaculture, the raising of aquatic species in a controlled environment, can be applied to farm ponds for both commercial and home use of the fish produced. Less intensive management of farm ponds can produce populations of good sport fish. Because farm ponds are not fulfilling their potential for fish production, there is an opportunity to expand this resource through more intensive management.

Table 6D-1.--Amount, size, distribution, and use of farmponds in the United States

	Recreation Fishing or Home Use Aquaculture		No Recreation Fishing or Home Use		Total	
	No.	Acres	No.	Acres	No.	Acres
AL	53,199	53,199	9,388	9,388	62,587	62,587
AK	0	0	13	13	13	13
AZ	65	58	7,992	7,992	8,057	8,050
AR	91,607	85,759	28,007	11,380	119,614	97,139
CA	202	1,200	6,350	24,000	6,552	25,200
CO	204	4,461	6,564	6,564	6,768	11,025
CT	300	1,600	100	300	400	1,900
DE	914	914	120	120	1,034	1,034
FL	13,971	18,763	2,287	4,301	16,258	23,064
GA	40,259	106,629	9,909	23,305	50,168	129,934
HI	1	53	240	678	241	731
ID	1,200	600	6,000	3,000	7,200	3,600
IL	27,547	27,547	14,454	14,454	42,001	42,001
IN	32,015	32,060	1,000	1,000	33,015	33,060
IA	37,405	37,405	2,053	2,053	39,458	39,458
KS	76,397	124,197	10,850	16,275	87,247	140,472
KY	98,000	25,000	120	405	98,120	25,405
LA	34,145	40,450	0	0	34,145	40,450
ME	2,025	508	2,100	2,100	4,125	2,608
MD	7,442	7,442	827	827	8,269	8,269
MA	1,900	800	1,400	525	3,300	1,325
MI	4,030	12,012	1,000	1,000	5,030	13,012
MN	27,000	27,000	5,000	5,000	32,000	32,000
MS	150,036	256,802	41,666	70,832	191,702	327,634
MO	300,000	235,000	20,000	15,000	320,000	250,000
MT	5,276	49,000	32,000	20,000	37,276	69,000
NE	11,600	17,400	48,000	48,000	59,600	65,400
NV	10	7	1,050	500	1,060	507
NH	1,200	360	1,000	300	2,200	660
NJ	4,052	526	0	0	4,052	526
NM	100	100	22,774	22,774	22,874	22,874
NY	25,460	25,460	7,639	2,291	33,099	27,751
NC	67,000	67,000	1,000	1,000	68,000	68,000
ND	31,026	31,026	24,115	24,115	55,141	55,141
OH	29,060	14,530	1,500	750	30,560	15,280
OK	85,939	80,000	100,000	95,000	185,939	175,000
OR	1,500	3,600	13,500	30,000	15,000	33,600
PA	13,129	13,129	1,000	800	14,129	13,929
RI	400	135	30	15	430	150
SC	31,061	59,859	2,743	5,442	33,804	65,301
SD	5,225	7,285	71,200	92,500	76,425	99,785
TN	98,400	33,080	6,020	1,804	104,420	34,884
TX	252,734	252,734	206,000	206,000	458,734	458,734
UT	124	206	9,100	9,100	9,224	9,306
VT	1,817	820	1,178	416	2,995	1,236
VA	38,739	48,497	8,207	6,124	46,946	54,621
WA	1,460	1,460	6,977	6,977	8,437	8,437
WV	15,016	15,016	5,085	5,085	20,101	20,101
WI	3,099	2,393	4,684	3,922	7,783	6,315
WY	1,200	300	21,250	21,250	22,450	21,550
CARIBBEAN	0	0	0	0	0	0
TOTAL	1,724,491	1,823,382	773,492	824,677	2,497,983	2,648,059

Streams

Status

There are two types of streams:

(1) Cold water streams, in which water is cold enough to permit the growth, reproduction, and survival of salmonids (trout, salmon, etc.).
(2) Warm water streams, in which the water is hot enough, at least during part of the year, to prevent the sustained growth, reproduction, and survival of salmonids.

To determine the location and extent of stream fisheries in the United States, Funk (1970) sent questionnaires to fisheries agencies asking about the status of cold and warm water streams in each of the 50 states. Figure 6D-1 shows the types of fisheries provided by streams. Cold water fisheries predominate in Alaska, Canada, the northern part of New England, the Lake States, and in mountain regions like the Appalachians, Rockies, Sierra Nevada, Cascades, and Coastal Ranges. Most streams are dry except after rainfall or snowmelt in the western part of the Great Plains, in the Great Basin and the Intermountain Region, and in the deserts of the Southwest. Consequently, there is little opportunity for fisheries in those areas.

Warm water fish predominate in at least some of the streams of 49 states. It is the only, or almost the only, type of stream fishing available in 29 states. According to estimates provided by state fisheries agencies, there are 305,625 miles of warm water fishing streams in the United States. Louisiana has the largest amount with 62,670 miles, Wisconsin has 27,000 miles, and Michigan 22,080 miles.

Warm Water Streams.--More than 550 species of fish inhabit warm water streams (Funk, 1970). Since the habitat requirements for each species differ, it is difficult to generalize about fish habitat and apply those generalizations to all species. Some species prefer riffles where the current is swift; some are found only in the slack water of sloughs and bayous. Some species tolerate both swift and slack water and others, like the paddlefish, may require both kinds of habitat to feed and reproduce. Fish that are widely distributed often have different habitat in different parts of their range. For example, smallmouth bass, rock bass, and walleyes are usually found in streams in the southern part of their ranges, but they are also common in northern lakes.

Widely sought sport fish found in warm water streams include largemouth, smallmouth, and spotted bass, striped bass, muskellunge, northern pike, walleye, and channel catfish. Less likely to provide trophies, but supplying a larger part of the total catch, are rock bass, pumpkinseed, bluegill, various other sunfishes, white and black crappies, white catfish, yellow, brown, and black bullheads, white bass, white perch, American shad, yellow perch, and chain pickerel. Other well known food fish are the sturgeons, paddlefish, carp, buffaloes, American eel, blue catfish, flathead catfish, and freshwater drum.

Figure 6D-1.--Location of streams which support warm water fish and cold water fish, and locations of streams which do not support a fishery. (Map used by permission of the American Fisheries Society.)

Cold Water Streams.--Beginning at the timberline and extending down to elevations of about 6,500 to 5,000 feet is a mountainous area characterized by the growth of pines and spruces. This is the high gradient valley zone of mountain trout streams. It is found in an irregular pattern between the west coast and the 110th meridian in Montana, the 108th meridian in Wyoming, and the 105th meridian in Colorado and New Mexico. Homogeneous stretches may be more than 30 miles long; others may be interrupted frequently by other kinds of trout stream stretches. There are comparable but smaller areas in the Appalachians, sometimes as low as 4,000 feet in altitude.

Mountain trout streams differ from each other most obviously in width and depth, but otherwise they are remarkably similar. The substrate is chiefly rubble, and there is great turbulence and more or less white water. Dissolved oxygen is always near 100 percent saturation. Temperatures are low during much of the year and seldom exceed 59° F in midsummer. Waters range from soft to hard; the hydrogen-ion concentration is almost invariably above pH 6.8; and total dissolved solids depend on the distance from their source, and on the time of year, volume of flow, and local geochemistry.

The bottom fauna consists chiefly of Diptera, Ephemeroptera, Plecoptera, and Trichoptera, and in most streams of the West the standing crop is low, about 11 grams per square meter (Pennak, 1978). The species composition varies with altitude and latitude, but the generic composition is remarkably homogenous. Many species show definite altitudinal patterns. Hynes (1970) maintains that among lotic habitat worldwide it is only the smaller stony streams that have a truly distinctive fauna. His "stony streams" include the category of tundra brooks and mountain trout streams discussed here.

Mountain streams usually have their heaviest flows during the spring runoff, but local heavy rains or cloudbursts may cause additional freshets at any time during the warm months. These heavy flows have a scouring effect, but it is remarkable to see how rapidly the bottom fauna recovers from its losses.

Periphyton is highly variable and ordinarily lowest shortly after spring runoff. Except for a few aquatic mosses, there are no growths of macrohydrophytes.

Depending on the locality, the dominant carnivorous fish is the rainbow, brook cutthroat, or brown trout, each of which should be capable of maintaining itself on a continuing basis if the stream is to qualify as a "mountain trout stream" (Pennak, 1978). Positive conditions do not exist in many of these streams, however, and the trout populations are not self-sustaining. Fish must be stocked to supply fishing demands.

There are many stretches of lowland streams in the northeastern states that might qualify marginally as "mountain trout streams" because they pass through coniferous forest and have persistent trout populations. Ordinarily, however, such stretches are short and have relatively low gradients throughout most of their length so their white water areas are restricted and scattered. In addition, the maximum summer temperature may often reach 64° to 70° F and there are frequent growths of rooted hydrophytes.

Condition

The water requirements for fish are based on instream flows, cover, and the quality of water necessary to meet habitat requirements. These water requirements are closely related to and interdependent with other instream requirements such as recreation, navigation, hydropower generation, and ecosystem maintenance. In addition, irrigated water management to control floods, erosion, and sedimentation greatly affects fish habitat, especially where the needs for these measures become competitive rather than complementary.

Water allocation problems basically stem from earlier decisions that placed constraints on future choices. With limited water resources available, we are now experiencing new water demands (e.g., environmental and energy), and they must compete with longstanding vested interests.

> Man's use of water falls into two modes: (1) instream uses such as hydropower generation, navigation, water conveyance, water assimilation, recreation, esthetics, estuarine inflow, and aquatic and riparian ecosystem maintenance (which includes support of the varied life forms), and (2) offstream uses such as irrigated agriculture, municipal water requirements, and industrial water requirements (including cooling water for energy plants). The allocation of the available water supply among these uses has always been a volatile issue in the West; and in certain areas of the East it is emerging as an issue of major importance. (USWRC, 1978).

The Second National Water Assessment (USWRC, 1978) provided the first nationwide examination of instream flow conditions and considered the implications of accelerated offstream uses of water. It analyzed the "requirements" for both consumed and nonconsumed water in 106 subregions and compared them to the supplies in those subregions. In conjunction with these analyses of flow, it approximated the minimum instream flow requirements for fish and wildlife. The approximations were based on professional judgment and the best information available on the needs of fish and wildlife for instream flow. See table 6D-2 at the end of this section.

In an initial attempt to classify rivers, the Water Resources Council compiled a series of maps for the Second National Water Assessment. The maps were based on existing state classification systems and information supplied by field personnel of the Fish and Wildlife Service's Ecological Services. They classified rivers on the basis of whether they contained nationally significant recreational fisheries and reproduction habitat for important anadromous species. This classification system was expanded to cover riverine habitat of endangered species, selected National Wildlife Refuges, stream reaches that are included or proposed for inclusion in the Federal Wild and Scenic Rivers System, and nationally significant commercial fisheries in inland rivers. In addition, the results available from the Fish and Wildlife Service's ongoing stream priorities project were added for nine states. An improved map of the Nation's rivers is available as a separate product of the Water Resources Council's Assessment.

Trends

Stream Alteration.--Stream alteration is a widespread problem for fish and wildlife populations. Dams, levees, dredging, and channelization, which manipulate rivers and streams, have been the traditional approaches in water management. Stream channelization for flood control and drainage often removes riparian habitat and disturbs the character of the streambed itself. Studies have shown that channelization may destroy a stream's ecosystem for a substantial period, sometimes for decades. However, the type and amount of stream modification determine the degree of adverse impacts. Great public awareness of the ecological consequences of such actions has led to a shift toward nonstructural solutions. Nonstructural water management offers exceptional opportunities for complementary greenway development and recreation use. The move to preserve our remaining natural stream systems is gaining momentum, stimulating demand for better inventory data and analytical techniques for assessing the values of riverine ecosystems.

Water Quality.--Water quality is vitally important to fish and wildlife. Although the quality of the Nation's streams is reportedly improving, nonpoint source pollution continues to be a major concern. The nonpoint pollutants are primarily contaminants carried by surface runoff from agricultural lands, urban developments, and sites disturbed by logging operations and construction. They contaminate the aquatic environment, the water supplies of downstream communities and industry, and eventually the estuarine ecosystems. Nonpoint source pollution remains a severe problem throughout most of the Nation (USDA, 1978b).

Table 6D-2.--Instream flow approximations (IFA) for fish and wildlife by regions and subregions

Region/Subregion	Instream flow approximations at outflow points (million gallons per day)
New England	
Northern Maine (0101)	33,350
Saco-Merrimack (0102)	8,810
Mass-Rhode Island-Coastal (0103)	4,003
Housatonic-Thames (0104)	4,218
Connecticut River (0105)	10,980
Richelieu (0106)	7,640
Mid-Atlantic	
Upper Hudson (0201)	11,010
Lower Hudson-Long Island-Northern NJ (0202)	13,870
Delaware (0203)	13,830
Susquehanna (0204)	21,390
Upper/Lower Chesapeake (0205)	12,330
Potomac (0206)	7,420
South Atlantic and Gulf	
Roanoke-Cape Fear (0301)	18,553
Pee Dee-Edisto (0302)	22,593
Savannah-St. Marys (0303)	19,474
St. Johns-Suwannee (0304)	15,058
Southern Florida (0305)	6,590
Apalachicola (0306)	19,033
Alabama-Choctawhatchee (0307)	35,809
Mobil-Tombigbee (0308)	36,110
Pascagoula-Pearl (0309)	15,435
Great Lakes	
Lake Superior (0401)	8,638
NW Lake Michigan (0402)	8,730
SW Lake Michigan (0403)	875
Eastern Lake Michigan (0404)	13,992
Lake Huron (0405)	6,410
St. Claire-Western Lake Erie (0406)	4,863
Eastern Lake Erie (0407)	4,028
Lake Ontario (0408)	16,415

Table 6D-2.--Instream flow approximations (IFA) for fish and wildlife by regions and subregions--Continued

Region/Subregion	Instream flow approximations at outflow points (million gallons per day)
Ohio	
Ohio Headwaters (0501)------------------	17,255
Upper Ohio-Big Sandy (0502)-------------	55,294
Muskingum-Scioto-MI (0503)--------------	9,613
Kanawha (0504)--------------------------	9,209
KY-Licking-GR-Ohio (0505)---------------	160,520
Wabash (0506)---------------------------	14,617
Cumberland (0507)-----------------------	18,968
Tennessee	
Upper Tennessee (0601)------------------	21,747
Lower Tennessee (0602)------------------	38,480
Upper Mississippi	
Mississippi Headwaters (0701)-----------	8,700
Bk-Root-Chippewa-WIS (0702)-------------	24,608
Rock-Miss-Des Moines (0703)-------------	38,250
Salt-Sny-Illinois (0704)----------------	57,250
Lower/Upper Mississippi (0705)----------	110,750
Lower Mississippi	
Hatchie-Miss-St. Fran (0801)------------	284,794
Yazoo-Miss-Ouachita (0802)--------------	319,540
Mississippi Delta (0803)----------------	359,033
Souris-Red-Rainy	
Souris-Red-Rainy (0901)-----------------	3,673
Missouri	
Mo-Milk-Saskatchewan (1001)-------------	4,542
Missouri-Marias (1002)------------------	3,650
Missouri-Musselshell (1003)-------------	4,192
Yellowstone (1004)----------------------	7,360
Western Dakotas (1005)------------------	11,063
Eastern Dakotas (1006)------------------	12,543
North/South Platte (1007)---------------	2,159
Niobrara-Platte-Loup (1008)-------------	3,285
Middle Missouri (1009)------------------	20,906

Table 6D-2.--Instream flow approximations (IFA) for fish and wildlife by regions and subregions--Continued

Region/Subregion	Instream flow approximations at outflow points (million gallons per day)
Kansas (1010)	3,706
Lower Missouri (1011)	33,958
Arkansas White Red	
Upper White (1101)	13,199
Upper Arkansas (1102)	431
Arkansas-Cimarron (1103)	2,867
Lower Arkansas (1104)	18,180
Canadian (1105)	2,347
Red Washita (1106)	2,020
Red-Sulphur (1107)	14,790
Texas-Gulf	
Sabine-Neches (1201)	8,560
Trinity-Galveston Bay (1202)	6,210
Brazos (1203)	3,360
Colorado (Texas) (1204)	1,357
Nueces-Texas-Coastal (1205)	3,430
Rio Grande	
Rio Grande Headwaters (1301)	347
Middle Rio Grande (1302)	833
Rio Grande-Pecos (1303)	1,360
Upper Pecos (1304)	298
Lower Rio Grande (1305)	2,287
Upper Colorado	
Green-White-Yampa (1401)	3,056
Colorado-Gunnison (1402)	3,623
Colorado-San Juan (1403)	7,947
Lower Colorado	
Little Colorado (1501)	200
Lower Colorado Main Stem (1502)	6,864
Gila (1503)	676

Table 6D-2.--Instream flow approximations (IFA) for fish and wildlife by regions and subregions--Continued

Region/Subregion	Instream flow approximations at outflow points (million gallons per day)
Great Basin	
Bear-Great Salt Lake (1601)	1,656
Sevier Lake (1602)	278
Humboldt-Tonopah Des (1603)	554
Central Lahontan (1604)	901
Pacific Northwest	
Clark Fort-Kootenai (1701)	19,209
Upper/Mid Columbia (1702)	89,094
Upper Central Snake (1703)	9,048
Lower Snake (1704)	21,533
Coast-Lower Columbia (1705)	178,673
Puget Sound (1706)	34,249
Oregon Closed Basin (1707)	1,082
California	
Klamath-N Coastal (1801)	16,597
Sacramento-Lahontan (1802)	9,077
San Joaquin-Tulare (1803)	2,841
San Francisco Bay (1804)	2,250
Central Calif. Coast (1805)	1,030
Southern California (1806)	343
Lahontan South (1807)	469
Alaska	
Alaska (1901)	859,000
Hawaii	
Hawaii County (2001)	2,154
Maui County (2002)	926
Honolulu County (2003)	294
Kauai County (2004)	1,216
Caribbean	
Puerto Rico (2101)	3,706
Virgin Islands (2102)	0

Source: Second National Water Assessment (USWRC, 1978).

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Section E-Aquaculture

Our Nation has a $2.6 billion annual trade deficit in fish products, which is about 10 percent of our total trade deficit (1978 figures). Fish imports account for 28 percent of our nonpetroleum deficit in trade. At the present time, only 3 percent of the fisheries products produced in the United States comes from aquaculture. In certain European countries, 10 percent of the fish products comes from aquaculture. In China and other Asian countries the figure is more than 40 percent (NAS, 1978). Fish are more efficient converters of feed to usable animal protein than any other animals. This is one reason that aquaculture is promoted in a number of foreign countries, particularly ones with large populations that need to produce food very efficiently. Fish flesh is a highly nutritious product that can be produced at low costs with minimal labor. Aquaculture requires less energy than other types of agriculture.

Commercial Fish Production

Catfish.--Catfish farming, or more appropriately channel catfish farming, began in the lower Mississippi River Delta in 1959. In 1960 there were approximately 250 acres in production. By 1963 this acreage had increased to 2,370. However, there are no data on production during those early years. Most of the fish grown were sold fresh in local markets. During 1965, an estimated 15 million pounds of channel catfish were produced in 14,000 acres of ponds. The majority of the fish were sold live to pay-lake operators. Approximately 10 percent or 1.5 million pounds of the 1965 production went to local food markets and restaurants (Klontz and King, 1975).

In 1968-69, there were 16,000 acres in production and an estimated 12-20 million pounds of processable catfish were sold. Almost 90 percent of the farms were in Mississippi, Arkansas, Louisiana, and Texas. During this period about $13.5 million was invested in ponds, equipment, fish, and processing facilities. In 1973 the National Marine Fisheries Service estimated that altogether 54,633 acres were used to produce catfish.

Currently there are some 3,802 catfish farmers in the Nation using 56,662 acres to produce catfish (table 6E-1). Although the acreage used has fluctuated, the overall trend has been steadily upward since the birth of the industry. Current figures indicate that more than 80 million pounds of fish were produced in 1977, a 60 percent increase over the 50 million pounds produced on 54,633 acres in 1973.

New processing plants and catfish food production plants, organized attempts at marketing this new product, and other improvements have assured more stable market conditions for catfish and are stimulating further growth in the industry.

Trout.--Raising trout for market in the United States began in the 1870's along the Atlantic coast. The main product of early commercial trout farms was the adult brook trout which was offered on the fresh fish markets of large eastern cities. The eggs stripped from the ripe females were only a

Table 6E-1.--Amount, size, and distribution of commercial food and baitfish production in the United States

	Catfish			Trout			Crawfish			Baitfish			Other			Total		
	No.	Acres	Feet	No.	Acres	Feet	No.	Acres	Ft.	No.	Acres	Ft.	No.	Acres	Feet	No.	Acres	Feet
AL	2,000	10,000	0	4	0	800	0	0	0	80	60	0	0	0	0	2,084	10,060	800
AK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AZ	4	30	0	2	60	0	0	0	0	2	6	0	4	9	0	12	105	0
AR	457	10,175	0	3	2	400	5	1.5	0	362	22,377	0	6	161	0	833	32,716.5	400
CA	110	1,200	1,100	50	39	12,050	6	70	0	23	400	0	89	278	570	278	1,987	13,720
CO	3	2	0	28	376	500	0	0	0	0	0	0	41	1,740	42	72	2,118	542
CT	0	0	0	0	0	0	0	0	0	80	40	0	5	4	0	85	44	0
DE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FL	47	235	0	0	0	0	0	0	0	5	137	0	254	1,631	0	306	2,003	0
GA	115	335	17,440	22	10	6,250	0	0	0	29	92	0	6	19	500	172	456	24,190
HI	17	19	0	0	0	0	0	0	0	9	3	0	46	180	0	72	202	0
ID	2	0	1,000	85	0	200,000	0	0	0	0	0	0	2	0	500	89	0	201,500
IL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IN	0	0	0	0	0	0	0	0	0	1	3	0	7	180	0	8	183	0
IA	0	0	0	0	0	0	0	0	0	5	10	0	0	0	0	5	10	0
KS	95	988	0	2	6.25	0	0	0	0	29	1,384	0	20	195	0	146	2,573.25	0
KY	30	180	0	0	0	0	0	0	0	0	0	0	0	0	0	30	180	0
LA	98	1,565	0	0	0	0	205	40,300	0	7	1,900	0	8	55	0	318	43,820	0
ME	0	0	0	10	5	5,000	0	0	0	15	10	0	9	8	0	34	23	5,000
MD	0	0	0	1	2	0	0	0	0	2	6	0	4	20	0	7	28	0
MA	0	0	0	11	20	0	0	0	0	2	2	0	1	1	0	14	23	0
MI	20	15	0	77	39	0	1	0.5	0	37	48	0	72	55.5	0	207	158	0
MN	0	0	0	30	150	0	0	0	0	50	12,000	0	0	0	0	80	12,150	0
MS	163	23,500	0	0	0	0	0	0	0	33	1,500	0	0	0	0	196	25,000	0
MO	124	772	0	15	55	0	34	153	0	89	1,009	0	152	1,773	0	414	3,762	0
MT	0	0	0	50	161	90	0	0	0	0	0	0	0	0	0	50	161	90
NE	7	14	0	10	20	0	0	0	0	7	10	0	15	30	0	39	74	0
NV	1	3	0	2	1	0	0	0	0	3	8	0	3	2.5	0	9	14.5	0
NH	0	0	0	4	6	0	0	0	0	0	0	0	0	0	0	4	6	0
NJ	3	5	100	1	0	10,000	0	0	0	0	0	0	3	5	150	7	10	10,250
NM	1	1	0	4	1	0	0	0	0	2	6	0	2	6	0	9	14	0
NY	0	0	0	32	11	0	0	0	0	3	6	0	6	9	0	41	26	0
NC	2	75	0	12	16	5,500	0	0	0	6	120	0	4	62	0	24	273	5,500
ND	0	0	0	1	2	0	0	0	0	5	35	0	0	0	0	6	37	0
OH	33	330	0	19	190	0	0	0	0	44	220	0	0	0	0	96	740	0
OK	47	940	0	0	0	0	1	5	0	39	538	0	0	0	0	87	1,483	0
OR	0	0	0	0	0	0	0	0	0	0	0	0	20	20	0	20	20	0
PA	7	7	0	69	69	0	0	0	0	75	150	0	0	0	0	151	226	0
RI	0	0	0	1	4	0	0	0	0	20	4	0	1	2	0	22	10	0
SC	13	19	0	5	0	600	8	40	0	94	86.5	0	20	20	0	140	165.5	600
SD	0	0	0	5	27	200	75	100	0	256	1,100	0	0	0	0	336	1,227	200
TN	6	59	600	1	0	1,450	0	0	0	4	450	0	1	1	0	12	510	2,050
TX	396	6,191	0	4	17	0	105	1,302	0	7	82	0	12	80	0	524	7,672	0
UT	0	0	0	12	480	0	0	0	0	0	0	0	0	0	0	12	480	0
VT	0	0	0	1	1	0	0	0	0	4	7	0	0	0	0	5	8	0
VA	1	2	0	11	0	23,936	0	0	0	9	13	0	10	13	0	31	28	23,936
WA	0	0	0	20	0	10,000	121	150	0	12	15	0	0	0	0	153	165	10,000
WV	0	0	0	3	4	0	0	0	0	0	0	0	13	22	0	16	26	0
WI	0	0	0	43	24	0	0	0	0	94	103	0	26	44	0	163	171	0
WY	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	3	2	0
CARIBBEAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	3,802	56,662	20,240	653	1,800.25	276,776	561	42,122	0	1,544	43,940.5	0	862	6,626	1,762	7,422	151,150.75	298,778

Source: SCS field study (1978)

secondary saleable item. In the early 1900's brook trout farming became quite important. Fish farms increased in number and existing farms increased their capacities by constructing extensive raceways.

Rainbow trout were officially introduced into the waters of the eastern United States in the 1880's. But they were not introduced into commercial fish farming until the early 1900's. Prior to that time they were raised primarily as a hobby by private fishing clubs.

From the early 1920's until after World War II, private trout hatcheries developed very slowly because of the high availability of sport-caught fish and the low market demand. Since the late 1940's, however, the trout industry has grown very rapidly. The most rapid growth has been in the processed fish segment of the industry.

The 1974 United States production of marketable trout was approximately 18 million pounds. The 1977 estimate of trout production was more than 35 million pounds, nearly double the figure 3 years earlier. Most trout are produced in Idaho, which contains about 200,000 of the 276,776 feet of trout raceways in the Nation. The Snake River Canyon in southern Idaho has an abundant supply of water of optimum quality for trout growth. This is the primary reason that commercial trout production is concentrated in that state.

Even without complete production data, it is safe to say that the trout industry is growing. Support for this view comes from feed manufacturers who indicate that they are selling more trout feed than ever before. Egg producers are also making similar comments about egg sales. The major question that arises is whether the increased demand for feed and eggs is the result of increased production by existing farms or by new farms and fee-fishing ponds.

Bait Fish.--This multimillion dollar business is a uniquely American enterprise. Its main goal is to produce live bait for sport fishermen. The industry is relatively new and has grown up over the past 30 years. However, it was preceded for many years by the commercial harvesting and sale of wild stocks (table 6E-1).

There are no data on bait fish production. But a well managed farm should produce around 100,000 minnows per acre, per year. Applying this estimate to existing acreage figures, the projected production is well over 4 billion fish annually.

The demand for bait minnows is always increasing because of the continuous growth of sport fishing. Nearly 54 million people fished in 1975, more than participated in any other type of outdoor recreation. Although the acreage devoted to bait fish has remained fairly constant during recent years, better production techniques, e.g., aeration, heavier feeding, improved water quality, and disease treatment, have enabled bait fish producers to meet increased demands.

Crawfish.--The freshwater crawfish industry began in the 1880's. There were major harvest areas in the Pacific Northwest, Wisconsin, and Louisiana.

Before 1960, nearly all crawfish were harvested from the wild and sold live in local markets for food or they were exported. At the same time that the demand for crawfish began to grow, there was a loss in their natural production areas and crawfish supplies from wild populations became depleted and undependable. Since 1960, procedures have been developed to manage, harvest, and use commercial and recreational crops of crawfish.

In recent years, Louisiana has dominated the crawfish industry producing the majority of the Nation's 11 million pounds of crawfish. Of the 42,122 acres of ponds now managed for crawfish in the United States, 40,300 are in Louisiana (table 6E-1). In Texas, the only other state with a significant acreage, 105 farmers manage 1,302 acres of water. Much of the crawfish production in other states is used for bait rather than food, with the possible exception of the state of Washington.

Farmers raise crawfish most often along with rice by annually rotating rice and crawfish on a given unit of land. They also build levees and dikes around areas that have native crawfish and then manage those areas for a crop of crawfish.

Farming crawfish is less intensive than farming any of the other commercially cultured fish. Current production techniques consist mostly of altering water levels and relying on some type of native vegetation or rice stubble to simulate natural conditions. Trapping is used for harvesting. While research is being done on feeding supplements, fertilization, and other practices which could increase production, farmers generally manage ponds to keep labor and costs at the lowest possible levels rather than to maximize production. Although up to 700 pounds of crawfish can be produced per acre, 300 to 400 pounds per acre is generally what is achieved using the most common management practices.

The crawfish industry now includes fishermen who both catch wild crawfish and lease rights to catch crawfish in managed ponds; farmers who harvest crawfish from ricefields; dealers in live crawfish; peeling and processing plants; seafood markets; and grocery stores. There are also thousands of individuals who catch crawfish for personal use.

Approximately 90 percent of the total crawfish crop is sold and consumed in Louisiana. But as the industry develops, there is little doubt that additional markets will form in other states and foreign countries which now buy small amounts of crawfish from Louisiana. Conditions are suitable for crawfish production in Texas, Arkansas, Mississippi, and other states that have climatic, soil, and water conditions suited to rice production.

Other Species.--Small amounts of other finfish and shellfish are cultured commercially. However, the aquaculture industry is dominated by catfish, trout, bait fish, and crawfish. Other freshwater species raised are small mouth buffalo, tillapia, freshwater prawns, various carps, and frogs. Lack of technology or poor market conditions constrain large scale cultural development of these species at present. Much the same can be said about marine or anadromous species such as salmon, oyster, marine shrimp, lobster, clams, abalone, and scallops. Although market conditions are good to excellent for these species, there has been no large scale commercial

development of them as cultured items. Legal, social, and technological constraints appear to be preventing the growth of aquaculture of these species (NAS, 1978).

Fee Fishing.--This activity, usually centered around catfish and trout, involves stocking fish in a pond where the public can fish for them for a fee. The fee is usually based on the number or pounds of fish caught. The stocked fish are commonly purchased from an aquacultural enterprise for this purpose. Fish are usually of catchable size and the operator manages the pond to increase the weight of the fish.

Fee fishing enterprises are popular in the United States and 117,000 acres of ponds are devoted to them. Georgia leads the states with 17,037 acres of catfish fee-fishing ponds followed by Texas with 6,191 acres and Illinois and Missouri with 3,500 acres each. Colorado, with 200 operations covering 3,850 acres leads the states in trout fee-fishing ponds followed by Pennsylvania with 1,850 acres (table 6E-2).

Table 6E-2.--Amount, size, and distribution of fee-fishing operations in the United States

	Catfish			Trout			Other			Total		
	No.	Acres	Feet	No.	Acres	Feet	No.	Acres	Feet	No.	Acres	Feet
AL	725	2,500	0	2	7	0	0	0	0	727	2,507	0
AK	0	0	0	0	0	0	0	0	0	0	0	0
AZ	2	16	0	2	20	0	0	0	0	4	36	0
AR	119	1,126	0	8	20	0	33	4,522	0	160	5,668	0
CA	70	400	0	50	100	0	82	700	0	202	1,200	0
CO	2	11	0	200	3,850	0	2	600	0	204	4,461	0
CT	0	0	0	5	5	0	2	2	0	7	7	0
DE	0	0	0	0	0	0	0	0	0	0	0	0
FL	80	121	0	0	0	0	56	642	0	136	763	0
GA	414	17,037	0	19	9	0	787	26,048	0	1,220	43,094	0
HI	0	0	0	1	15	0	0	0	0	1	15	0
ID	0	0	0	30	200	0	0	0	0	30	200	0
IL	157	3,500	0	17	385	0	0	0	0	174	3,885	0
IN	10	50	0	3	3	0	200	500	0	213	553	0
IA	10	10	0	3	3	0	5	5	0	18	18	0
KS	4	21	0	0	0	0	272	494	0	276	515	0
KY	0	0	0	0	0	0	90	225	0	90	225	0
LA	16	65	0	0	0	0	25	500	0	41	565	0
ME	0	0	0	10	20	0	0	0	0	10	20	0
MD	0	0	0	3	3	0	0	0	0	3	3	0
MA	0	0	0	60	300	0	0	0	0	60	300	0
MI	20	15	0	69	35	0	68	51.5	0	157	101.5	0
MN	0	0	0	5	60	0	5	30	0	10	90	0
MS	35	1,800	0	0	0	0	705	1,199	0	740	2,999	0
MO	141	3,500	0	9	141	0	125	6,826	0	275	10,467	0
MT	0	0	0	6	24	0	0	0	0	6	24	0
NE	0	0	0	9	18	0	0	0	0	9	18	0
NV	0	0	0	0	0	0	0	0	0	0	0	0
NH	0	0	0	0	0	0	3	6	0	3	6	0
NJ	0	0	0	2	2.5	0	0	0	0	2	2.5	0
NM	6	4	0	4	16	0	0	0	0	10	20	0
NY	0	0	0	64	452	0	29	444	0	93	896	0
NC	0	0	0	54	50	0	0	0	0	54	50	0
ND	0	0	0	3	0	1.5	0	0	0	3	0	1.5
OH	109	1,223	0	49	364	0	149	4,173	0	307	5,760	0
OK	15	241	0	0	0	0	0	0	0	15	241	0
OR	0	0	0	11	25	0	0	0	0	11	25	0
PA	113	1,100	0	197	1,850	0	422	7,448.25	0	732	10.398.25	0
RI	0	0	0	4	13	0	1	50	0	5	63	0
SC	21	63.5	0	4	1.75	0	145	635.5	0	170	700.75	0
SD	0	0	0	5	6	0	50	500	0	55	506	0
TN	33	270	710	12	20	5,550	3	61	0	48	351	6,260
TX	95	6,191	0	2	11	0	2,162	9,279	0	2,259	15,481	0
UT	1	1	0	5	20	0	0	0	0	6	21	0
VT	0	0	0	4	18	0	2	2	0	6	20	0
VA	2	3	0	24	421	0	106	3,162.5	0	132	3,586.5	0
WA	0	0	0	50	75	0	10	15	0	60	90	0
WV	33	906	0	7	40	0	0	0	0	40	946	0
WI	0	0	0	73	85	0	16	16	0	89	101	0
WY	0	0	0	1	0.5	0	0	0	0	1	0.5	0
CARIBBEAN	0	0	0	0	0	0	0	0	0	0	0	0
Total	2,233	40,174.5	710	1,086	8,688.75	5,551.5	5,555	68,136.75	0	8,874	117,000.00	6,261.5

Source: SCS field study (1978)

References

Klontz, George W., and John G. King. 1975. Aquaculture in Idaho and nationwide. Idaho Dep. Water Resour. Res. Inst. 87 pp. and append.

National Academy of Sciences. 1978. Aquaculture in the United States. 93 pp.

Section F-Wildlife Habitat

All land has the potential or capability to produce and sustain wildlife. Admittedly, all lands are not equal in the kinds of wildlife they can produce nor in the numbers of animals they can produce and sustain. Inherent factors, such as climatic and soil characteristics, limit the kinds and numbers of wildlife. These limitations are usually natural and generally little can be done to overcome them.

Exceptions, of course, can be noted. Irrigation can alter climatic limitations and permit changing from one land use to another; construction of dams and reservoirs can provide water and aquatic habitat in an area where none may exist; or planting trees can create a woodland habitat in an area where woodlands are nonexistent. These and other created changes can alter the kinds and numbers of wildlife in a given locale. All such manmade changes usually require constant maintenance to prevent their reversion to former conditions.

Typically, wildlife use of agricultural lands is a secondary land use; important, but still secondary. The primary land use imposes limitations on the capabilities of the land to produce and sustain wildlife.

The land's capability to produce and sustain wildlife is related to its potential plant community, the stage of succession, and the plant community's spatial relationship to other kinds of plant communities both within and around it (figure 6F-1). The inherent wildlife capabilities of a plant community are subject to many limitations, both natural and manmade, that can change the plant community's composition and spatial arrangement. These factors influence the kinds and numbers of wildlife a plant community can produce and support. Various land uses and levels of intensity of management and technology may greatly alter or diminish this capability. Conversely, applying certain practices may enhance the capability of land to produce and sustain wildlife by overcoming or lessening the effects of the influence of man.

In this section, the more important human influences on extensive kinds of wildlife habitat are discussed by primary land uses and associated water areas. The sections on wetlands and riparian vegetation relate the status, condition, and trend of wildlife habitat.

Cropland Wildlife

Status.--Farms and croplands have long been recognized as major wildlife habitat. Agricultural soils are basically favorable to living organisms because they are fertile and have reasonably good moisture. Crops and associated vegetation provide food and cover for certain adapted birds and mammals typically referred to as farm wildlife, such as cottontail, fox squirrels, mourning doves, bobwhite quail, and pheasant.

According to the 1977 National Resource Inventories (USDA, 1978) there were 413.2 million acres of cropland in the United States in 1977--25.0 million fewer acres than in 1967. During the 8-year period from 1967 to 1975, 79.6 million acres of cropland were converted to other uses, while only 48.8

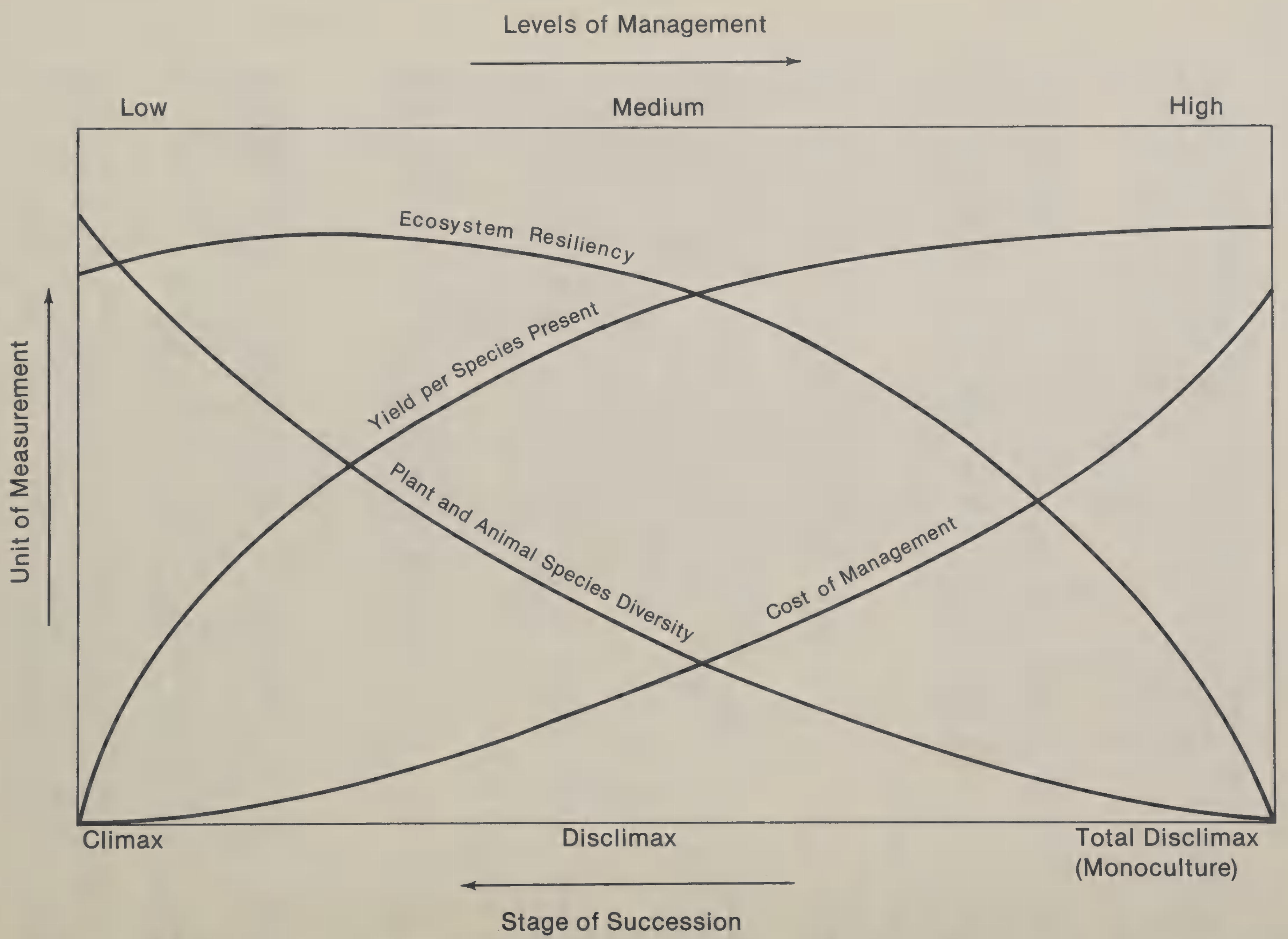

Figure 6F-1.--A schematic of the effects of change in successional stages of an ecosystem. (Adapted from Wetland Floodplain Management Seminar. U.S. Water Resources Council. A. L. Lugo. 1979.)

million acres were converted from other uses to cropland. With the exception of the Delta States, every farm production region in the United States had a net reduction in cropland during this period. The number of acres of cropland has been declining since 1958 (table 6F-1).

Table 6F-1.--Total acreage of cropland in the United States

Year	Total cropland acreage
1977	413,167,000 1/
1967	438,240,000 2/
1958	448,525,000 2/

1/ 1977 National Resource Inventories.
2/ 1967 and 1958 SCS Conservation Needs Inventories.

Condition.--Advancing agricultural technology has enabled farmers to increase crop production by farming fewer acres more intensively. As a result, more efficient use is made of each acre devoted to crop production. This is often accompanied by a reduction in the amount of hedgerows, field borders, grassy areas, woodlots, and other vegetation that are interspersed with cropland and provide diverse wildlife habitat. When farm holdings were small, crops diversified, and hedgerows, fence rows, and vegetated streambanks were common, cropland provided habitat for a wide variety of wildlife species. But in recent years farms have increased in size and, with increasing monoculture and mechanization, the quality of wildlife habitat has declined for many species.

Significant decreases in the number of farms and a substantial increase in farm size have characterized American agriculture since the turn of the century (tables 6F-2 and 6F-3). The average size of a farm almost tripled from 154.8 acres in 1935 to 439.5 acres in 1974. During the same period, the number of farms declined from 6.8 million in 1935 to 2.3 million in 1974. Of the 4.5 million farms that were lost between 1935 and 1974, about three-fourths were less than 100 acres in size and nearly half were less than 50 acres. An increase in cropland production has accompanied the loss in the number of farms. Since 1950, crop production per acre has risen by approximately 50 percent nationally. The trend toward larger, more intensively farmed units is evident. Two results of such farming advances have been the loss of vegetative diversity associated with crops and the degradation of wildlife habitat. The growth in the size of farms is related to an increase in the use of large farm machinery. The 1974 Census of Agriculture (USDC, 1974) showed a decline in both the number of farms reporting tractors and the number of tractors. However, that trend may be somewhat misleading, since the trend toward larger farming units does not necessarily require more tractors. Usually, the work is accomplished with larger tractors used more intensively. Between 1969 and 1974, the average number of tractors increased from 2.1 to 2.6 tractors per farm. For farms

Table 6F-2.--Number of farms by size, 1880 to 1974

Year	Total number	Farm size in acres: Under 3	3 to 9	10 to 29	30 to 49	50 to 99	100 to 499	500 to 999	1,000 and over
1974----	2,314,013	(128,254) 3/		(379,543)		384,762	1,059,220	207,297	154,937
1969----	2,730,250	78,868	83,243	(473,465)		459,942	1,268,127	215,659	150,946
1964----	3,157,857	59,686	122,895	(637,434)		542,430	1,439,683	210,437	145,292
1959----	3,710,503	79,083	165,245	(813,216)		657,990	1,658,530	200,012	136,427
1954 1/-	4,782,416	99,896	384,395	713,335	499,496	864,063	1,899,053	191,697	130,481
1950 2/-	5,388,437	78,110	410,420	855,000	624,596	1,048,075	2,068,466	182,297	121,473
1945 1/-	5,859,169	98,966	495,595	945,608	708,796	1,157,320	2,166,208	173,777	112,899
1940 2/-	6,102,417	37,025	472,325	(1,782,061)		1,291,328	2,255,396	163,711	100,574
1935 1/-	6,812,350	35,573	535,258	1,241,431	882,164	1,444,007	2,417,803	167,452	88,662
1930 2/-	6,295,103	44,244	317,755	(2,002,115)		1,375,198	2,315,403	159,723	80,665
1925 1/-	6,371,640	15,151	363,384	(2,038,692)		1,421,078	2,326,155	143,852	63,328
1920 2/-	6,453,991	21,158	270,348	(2,013,516)		1,475,005	2,456,729	149,826	67,409
1910 1/-	6,361,502	18,033	317,010	(1,918,499)		1,438,069	2,494,461	125,295	50,135
1900----	5,739,657	41,882	226,564	(1,664,797)		1,366,167	2,290,561	102,526	47,160
1890----	4,564,641	(150,194)		(1,168,327)		1,121,485	2,008,694	84,395	31,546
1880----	4,008,907	4,352	134,889	(1,036,323)		1,032,810	1,695,983	75,972	28,578

1/ Alaska and Hawaii not included.
2/ Includes farms of 100 acres or more for Hawaii.
3/ Figures in parentheses are combined data groupings.
Source: Census of Agriculture, 1974

with annual sales of $2,500 or more, the increase was from 2.4 to 2.6 tractors per farm. Generally, these are larger tractors capable of pulling larger, more sophisticated plows and seeders.

Table 6F-3.--Average size of farms: 1850 to 1974

Year	Average size of farms (acres)	Year	Average size of farms (acres)	Year	Average size of farms (acres)
1974--------	439.5	1940---------	174.5	1900--------	146.6
1969--------	389.5	1935 1/------	154.8	1890 1/-----	136.5
1964--------	351.6	1930---------	157.3	1880 1/-----	133.7
1959--------	302.8				
1954 1/-----	242.2	1925 1/------	145.1	1870 1/------	153.3
1950 1/-----	215.2	1920---------	148.5	1860 1/------	199.2
1945--------	194.8	1910---------	138.5	1850 1/------	202.6

1/ Alaska and Hawaii not included.
Source: Census of Agriculture, 1974.

Similar observations have been made about self-propelled grain and bean combines. In 1974, the Census of Agriculture (USDC, 1974) showed that both the number of farms with combines and the number of combines on farms increased. The increase was most dramatic in the north central region of the Nation where almost two-thirds of the combines are located. Such mechanization at first had a beneficial effect on the quality of wildlife habitat. The mechanical cornpickers and combines left more waste grain on the ground than was left after hand harvesting. Studies have shown that approximately 325 pounds of waste rice and weed seeds remained on the field following harvest (Harmon et al., 1960). Technical advancements, however, continue to boost the capabilities of today's new combines, and improvements in platform leveling techniques have made the use of larger combines possible. Some manufacturers now sell combines with head sizes as large as 24 feet. Many combines used primarily for soybean harvesting now have cutter bars designed to reduce harvesting loss. These advancements and the increasing number of grain farms large enough to use larger machines efficiently have spurred the manufacture of still larger combines.

Advances in other farming equipment such as crawler tractors, cornpickers, picker-shellers, mowers, hayrakes, and windrowers have all contributed to more efficient crop production and harvests. By the same token, improved farming equipment has also contributed to changing the pattern of agriculture from smaller "patch type" farming to the larger modernized unit, and has had an overall negative effect on cropland wildlife habitat. Monoculture contributes to the efficiency of farm operations but it requires large level unbroken fields. Creating these fields removes intervening vegetation and this adversely affects wildlife habitat. It is difficult to quantify the extent of monoculture using existing information. However, certain data show the apparent concentration of single crops in some areas

and, therefore, they indicate the location and extent of this condition and its influence on wildlife habitat. In 1973, 12 percent of the counties in the continental United States had 50 percent of their acreage in harvested cropland. (USDA, 1973). These counties were concentrated in North Dakota, South Dakota, Nebraska, Iowa, Minnesota, Illinois, Indiana, and Ohio. Twenty-nine counties exceeded 70 percent. Smaller areas were found in California, Washington, Kansas, Texas, Michigan, Arkansas, and Mississippi.

Monocultures are highly susceptible to invasion by weeds, insects, and other pests that decrease crop production. Pesticides have helped farmers combat these pests. More than 1,800 biologically active compounds are sold in more than 32,000 different formulations in the domestic market. The use of pesticides, particularly herbicides, has increased sharply in the last three decades but has declined slightly since 1975. In 1971, more than 158 million acres of land were treated with herbicides, 65 million with insecticides, and 7.5 million acres with fungicides. Farmers used about 60 percent of the 750,000 tons of pesticides produced in 1977 (USDA, 1978).

The detrimental effects of pesticides on wildlife are well documented (Bernard, 1963; Dewitt, 1956; Ratcliffe, 1967). Pesticides are now among the world's most widely distributed synthetic chemicals. Many are toxic to a broad spectrum of species and adversely affect many kinds of organisms. Some, such as chlorinated hydrocarbon insecticides, are very persistent and accumulate in the tissues of living organisms. The persistent nature of many pesticides, their toxicity and ability to be incorporated into food chains, and their increased use are the major factors contributing to concern about their negative effects on wildlife.

Windbreaks add vegetative diversity in areas where monoculture predominates. The beneficial effects of windbreaks for wildlife, such as feeding, nesting, and resting places, are well documented (National Research Council, 1970). A 1978 study in a five-state area of the Great Plains showed that the total area covered by windbreaks and the number of wide field windbreaks (more than 50 feet wide) are both decreasing. However, the total number of field windbreaks is rising primarily because of the increase in the number of narrow field windbreaks (less than 26 feet wide). The decrease in the size of windbreaks and other areas of intervening vegetation as a result of monoculture on vast expanses of land has had a major negative effect on wildlife habitat.

Another event resulting from advanced mechanization and agricultural technology is the almost routine fall plowing that can be observed throughout the Nation. Fall plowing removes crop residues and, therefore, destroys important wildlife food and cover. In the contiguous United States, during 1975, the residue was removed from more than 51 percent of the harvested cropland (USDA, 1977).

Wetlands have been drained or filled to create the larger fields for monoculture and this has had a negative effect on wildlife habitat. Although statistics vary, Shaw and Fredine (1956) estimated that at one time the contiguous states had approximately 127 million acres of wetland. Today some 40 percent or 51 million acres of wetlands that existed in the 48 states have been destroyed (Ladd, 1978). During the 1950's and 1960's,

dredging and filling activities destroyed about 30,000 acres of coastal habitat annually. By 1970, three-fourths of all coastal habitat having significant wildlife value had been moderately to severely degraded (Ladd, 1978).

Approximately 104 million acres of wet soils in the United States have been drained and are currently cultivated (Dideriksen et al., 1978). This acreage is about one-fourth of all the cropland in the country. Since we cannot directly correlate wet soils and wetlands, it would be incorrect to assume that all of the 104 million acres of wet soils drained for agricultural production were wetlands. Much of the acreage drained for crop production does not qualify as wetlands according to Circular 39. Only 1,291,000 acres of cropland are classed as 3-20 wetlands.

One of the primary purposes of drainage is to convert areas too wet to be farmed into productive agricultural land. When adequately drained, wetlands are among the most productive soils and contribute significantly to the economy and agricultural infrastructure of the Nation. The gain of valuable agricultural land through drainage has often been at the expense of wetland wildlife and other species that use wetlands to a lesser degree.

While certain advances in farming technology have resulted in an overall deterioration of wildlife habitat, others have occurred that favor wildlife. New tillage systems such as no tillage cropping, minimum tillage, stubble mulching, and conservation tillage are more beneficial to wildlife than conventional tillage practices.

The trend toward conservation tillage is increasing steadily. According to the SCS reporting system the practice of "conservation tillage," which includes no-tillage, strip tillage, stubble mulching, and other types of nonconversion tillage, increased from 3,769,831 acres in 1963 when the practice was first reported to 39,161,000 acres in 1976. Conservation practices such as stripcropping, field borders, hedges, tree plantings, bench terraces, and others are increasing annually and also contribute to wildlife habitat on cropland.

The acreage of irrigated land has increased sharply (USDA, 1978). In 1967, 48 million acres of cropland and pasture were irrigated; in 1977, the total was 62 million acres. Three states irrigate more than 5 million acres each and 14 states irrigate 1 to 5 million each.

In some situations the land use changes brought about by irrigation have added diversity to the ecosystem. In other situations where extensive monocultures have developed, irrigation has had the opposite impact on wildife habitat.

Woodland Wildlife

Status and Trend.--Within the 50 states, 662 million acres are classified as woodland. This acreage includes forest land suitable for growing continuous crops for commercial products and noncommercial forest land which is either legally assigned to recreation (parks, wilderness, or other nontimber uses) or is commercially impractical to harvest because of its low productivity.

According to the Forest Service's 1979 draft of the RPA Assessment, 73 percent of all commercial timberland was privately owned in 1977. Twenty-seven percent was in federal, state, and other public holdings. The forest industry owns nearly 14 percent of the private commercial timberland. The area it owns has been increasing while the amount owned by other private owners has declined. Moreover, the industry's stewardship now extends to substantial acreages of forest land that are under long-term leases obtained from farmers and other owners.

Farms and other private holdings constitute about 58 percent of the commercial timberland. Many of these holdings are small, some less than 10 acres, and are managed in ways that are not compatible with timber harvesting. Part of this acreage is in suburban areas. While small size, differing management objectives, and location may preclude using these woodlands for timber, their interspersion with other types of habitat make them a valuable asset for wildlife.

Hardwood forest types made up primarily of oaks, hickories, gum, maple, birch, aspen, and other deciduous species occupied more than half the commercial timberland area in 1977. More than two-fifths was occupied by the southern pines, Douglas-fir, hemlock, spruce, and other softwood species. The rest, about 4 percent, does not have sufficient tree cover to determine the forest type and is classified as nonstocked. The area of commercial timberland rose from 500 million acres in 1952 to 511 million in 1962. Since then, there has been a slow decline because of land use conversion to cropland, pasture, roads, residential areas, parks, and wilderness areas. A slowdown in the reversion of abandoned cropland and pasture to forest has also contributed to the decline (USDA, 1979).

Condition.--The Society of American Foresters recognizes 156 timber types that vary widely in age, species composition, size, and other respects. The wildlife that use woodlands are equally diverse. There are 837 species of birds, 325 species of mammals, 157 species of amphibians, and 231 species of reptiles that inhabit forest ecosystems in the United States (USDA, 1979). A single wildlife species may occupy one or several timber types and may do so in one or several successional stages. The daily and annual range occupied by a species may vary from a few acres or less (fox squirrel), to a square mile (deer), or up to 36 miles or more (wide-ranging carnivores). Many woodland wildlife species are "edge species" (deer, turkey, grouse) and require openings and early forest successions which provide interspersed types of plant communities.

New technology that has improved timber management has resulted in more intensive management in much of the Nation's woodlands. Timber management, regardless of its objectives, affects wildlife habitat. The emphasis on wood production dictates practices that encourage the establishment and rapid growth of trees. These practices promote early successional stages of forest development and, therefore, favor species of wildlife associated with those stages. The short rotation practices decrease the age of the forest stand in the interest of an early harvest of marketable trees. This type of timber management eliminates old growth and dying trees. Therefore, it also eliminates the wildlife associated with advanced successional stages such as woodpeckers and other birds and mammals that nest in cavities.

Management that promotes timber of all ages produces a multistoried or layered forest, dominated by relatively mature trees. This kind of management provides a variety of successional stages in the forest stand (e.g., grass, forbs, shrub seedlings, pole saplings, young forest, and mature forest). The vertical diversity of vegetation then offers an increased variety of niches for a number of adapted animal species.

Wildlife species that require "edge" are favored by practices that promote forest management in patterns. Management that encourages different patterns of timber adjacent to one another creates plant communities in various stages of succession. The size and shape of the management units will determine the amount of edge. Clearcutting greatly affects edge species and habitat diversity. When clearcutting is practiced on small blocks, diversity may increase and there may be an overall gain in wildlife habitat. When clearcutting is practiced on larger blocks, the reverse may be the result. Where timber production is the primary land management activity, the wildlife present will be the result, planned or unplanned, of such management. However, the focus of the land management activity can be on wildlife and woodland management practices can be used to create, maintain, or enhance wildlife habitat by controlling the condition of the stand.

About 63 percent of the commercial timber in the United States is in sawtimber trees (trees large enough to contain at least one log suitable for the manufacture of lumber). Trees of this size provide food and cover for many species. Acorns, beechnuts, hickory nuts, and other forest mast are favorite foods of squirrels, songbirds, turkeys, deer, and other game and nongame wildlife. Trees of sawtimber size characteristically produce more mast than pole size timber and are generally more valuable as a food supply. Since older and larger trees contain more natural cavities than young ones, they are also more important in providing shelter to species that nest in cavities, such as wood ducks, squirrels, woodpeckers, nuthatches, and racoons.

Approximately 26 percent of commercial timber is pole timber (trees from 5 inches in diameter at breast height up to sawtimber size). Certain species of pole timber provide berries, fruit, mast, and browse used by many wildlife species. Because much of the pole timber is regrowth from previously harvested stands, this acreage is in the early stages of forest succession. Deer, rabbit, woodcock, and other species that depend on regrowth for browse or dense cover are associated with pole timber stands or those stages of succession immediately preceding.

The remaining 11 percent of commercial timber is rotten cull and dead trees. In the past, high-grading, burning, and grazing practices have created stands with increased volumes of cull (Gingrich, 1970). Stands with an overstory or high frequency of cull trees create a unique habitat with abundant natural cavities and many hollow trees suitable for excavating cavities. With more intensive forestry practices and removal of cull trees by thinning and harvesting, natural cavities are lost. Some cavity-nesting species are now declining, and one, the ivory-billed woodpecker, is believed to be extinct.

Grazing of forest ecosystems can affect the quality of the wildlife habitat and in many instances decrease forest regeneration. Livestock can compete with wild animals for food and overgrazing can reduce the cover value of the understory vegetation. When a domestic species of animal overuses its preferred food plants, it is forced to feed on other plants, and thus competition which would not occur on properly grazed woodlands would begin. Any type of grazing on hardwood forest and western riparian areas or steep, rocky slopes is usually detrimental.

Very few areas of forest land in the South, Northeast, upper Midwest, and Lake States are improperly grazed. Data indicate that most forest areas of the West are grazed and in many instances need protection and improvement.

Range Wildlife

Status.--Approximately 414 million acres of the Nation's land are rangeland. When properly managed, rangeland provides habitat for a wide variety of wildlife species. Sage grouse, prairie chicken, pronghorn, prairie dogs, lark buntings, and other wildlife associated with grasslands depend primarily on rangeland. Rangeland and its associated wildlife are located primarily in 17 western states where climatic conditions favor grassland communities.

Condition.--The quantity and quality of wildlife habitat on rangeland depend on the primary land management system. Since poor condition rangeland provides low quality grazing for livestock, it also provides poor habitat for most species of range wildlife. Livestock and other grazing animals affect the vegetation and soils on rangeland. They can trample or overgraze vegetation and compact the soil so that its ability to absorb water is reduced. Competition among animal species has an important influence on the condition of wildlife habitat.

Wildlife and livestock grazing are discussed by Wagner in "Wildlife In America" (CEQ, 1978). Wagner points out that interaction between pairs of species in an ecosystem may range from negative, to neutral, to positive for one or both species.

The generalized scheme shown in figure 6F-2, as presented by Wagner, indicates the potential for competition among animals feeding on the same vegetation. Competition is most likely between two species with essentially similar feeding niches in the same ecosystem. Where they occur together, cattle are potential direct competitors of bison and bighorn. Domestic sheep may be substantial competitors of pronghorn goats, which occur in significant numbers only in Texas. Sheep are direct competitors with deer. The horse, with its broad feeding spectrum, is a potential competitor of nearly all the wild ungulates with which it coexists. Among the wild species, the elk is the broadest spectrum feeder and, to some degree, is potentially a competitor of nearly all the other species, wild or domestic.

Competition is least likely to occur between two coexisting species with very different feeding niches, as with cattle and deer, or goats and bison. When a species overuses its preferred food plants and reduces their abundance, it is forced to feed on less preferred plants. Thus, two her-

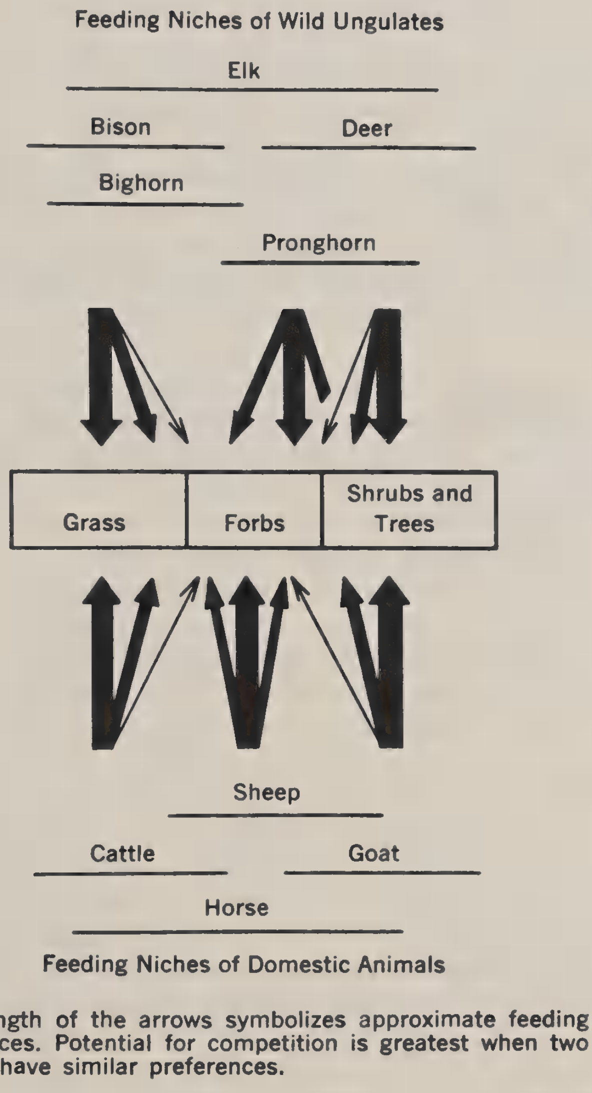

Figure 6F-2.--Feeding niches of wild ungulates and domestic herbivores and potential competition between them.

bivorous species which would not compete materially in a system with healthy, diverse vegetation might converge and compete where vegetation is degraded.

In a 1977 study, SCS state range conservationists estimated that 12 percent of our nonfederal rangeland was in excellent or near climax condition, 28 percent was good, 42 percent fair, and 18 percent poor. While the quantity of forage for livestock and wildlife does not correlate directly with fair, good, or excellent condition, rangeland in poor condition almost always yields less than 25 percent of the forage it could produce and thus induces competition between species. Poor range condition usually harms both livestock and wildlife that depend on forage for either food or cover.

Figure 6F-3, prepared by Wagner for "Wildlife in America" (CEQ, 1978), compares the grazing pressure applied by native animals on rangeland in 11 western states with that applied by livestock. Wagner concludes that "one may infer from all of these estimates that western ranges were able to withstand removal by wild animals to the extent of 80 million AUM's (animal unit months of grazing) and maintain themselves in near climax state. But a 75-year history of pressure at 50 percent higher than this level has been excessive and ranges have deteriorated."

Trend.--Mechanical brush control has mixed effects on wildlife. Altering habitat by limiting or eliminating woody plants may reduce the number of wildlife species that depend on shrubs for food, cover, or nesting. Creating new habitat types and habitat diversity by converting solid brush stands to areas interspersed with grass can increase some types of wildlife. Creating irregularly shaped grass areas and areas interspersed with brush increases the edge effect. Converting certain types, such as pinyon-juniper, increases the production of shrubs, forbs, and grasses valuable as forage for quail and turkey and for grazing animals, such as deer and elk. But removing pinyon-juniper or other brush may eliminate nesting sites and habitat for some other species.

Converting a brush area will usually benefit some kinds of wildlife at the expense of others. For example, improving deteriorated rangelands through sagebrush control and grass seeding may favor antelope and other wildlife that prefer open grasslands to unbroken sagebrush. Sage grouse depend heavily on sagebrush for food and cover and their habitat may be eliminated when large blocks of sagebrush are treated. The number of cottontails and shrub-nesting birds may decline after the loss of shrub cover.

The use of chemicals for brush control has varying effects on wildlife depending on the herbicide and the carrier used. The use of recommended herbicides and proper application procedures help minimize detrimental effects on wildlife habitat. Generally, the detrimental effects on wildlife result from modification of the plant community, rather than from the toxicity of the herbicide. The removal of a target plant species may reduce the numbers of those wildlife species that depend on it for food or cover even though the chemical is not directly harmful to them. For example, sage grouse depend on sagebrush, a plant often controlled by chemicals. When properly planned and applied, brush management can maintain, enhance, or create wildlife habitat if the cover and food that a given

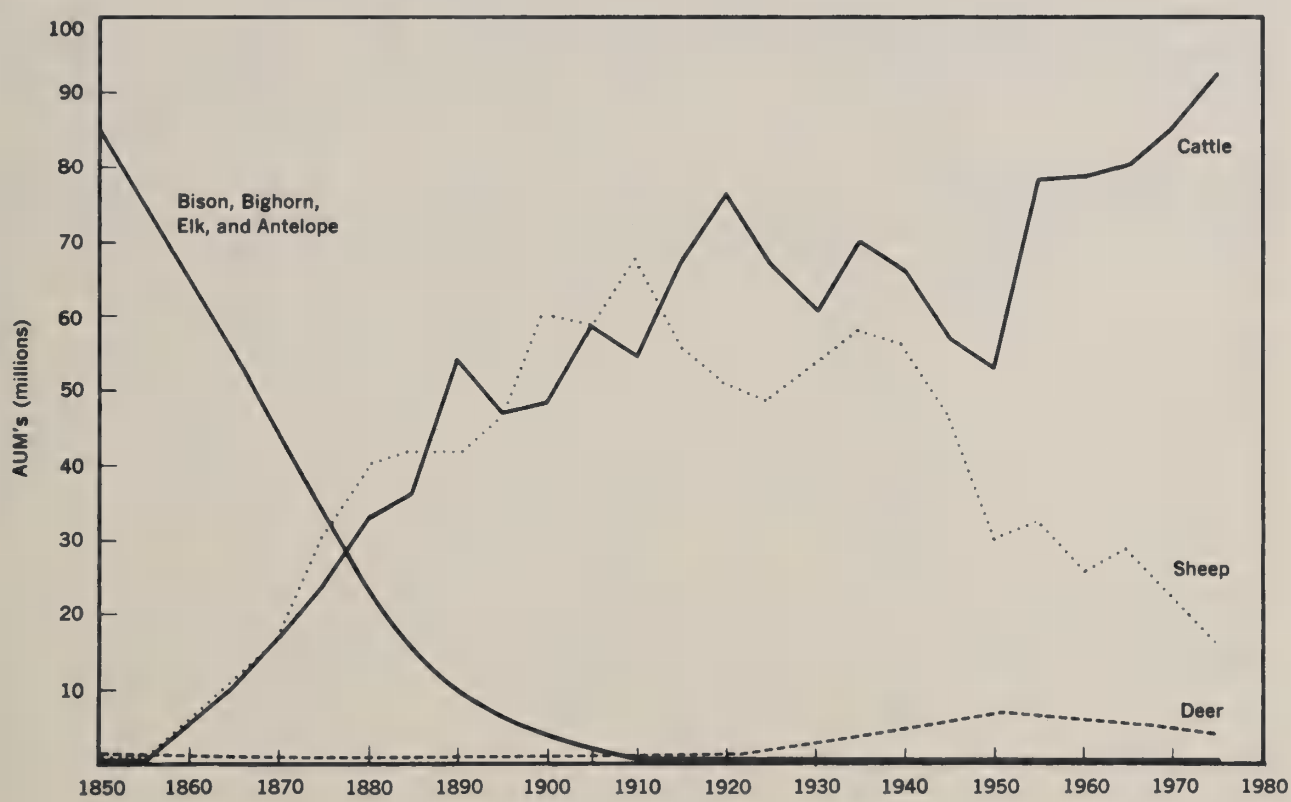

Figure 6F-3.--Conjectured AUM's of wild and domestic grazing pressures on rangelands of the 11 western states.

wildlife species or group requires is considered. Mechanical and chemical brush management has been applied on 59,047,738 acres nationally and is being installed on an additional 1 million acres annually.

Other range management practices such as reseeding and planned grazing also affect wildlife habitat. Rangeland seeding establishes desired adapted plants. Food and cover for wildlife can be created by including plant species in a range seeding mixture that will improve plant and habitat diversity. There has been rangeland seeding on 7,038,321 acres nationally and 140,000 more acres are seeded annually.

Planned grazing systems can be used to reduce the competition for forage between livestock and wildlife herbivores. The time of deferment can be scheduled to favor plants that maintain food, cover, or both for desired wildlife. Grazing systems can be developed to control grazing at an intensity that will leave enough cover to protect the soil and maintain or improve the quantity and quality of desired vegetation. Proper grazing is most beneficial to wildlife species when it reduces competition for food, maintains diversity in the plant community, and provides the herbaceous vegetation height they need for food and cover. There are planned grazing systems on 76,542,551 acres. In 1977, about 30,976,770 acres of planned grazing systems were installed.

Generally, no single land use practice can maintain or create acceptable wildlife habitat. More often, a combination of practices installed in a proper mix with existing habitat elements is necessary to meet the needs of a given wildlife species (table 6F-4).

Table 6F-4.--Supporting practices for wildlife upland habitat management

Habitat needs	Trees and shrubs cover (food)		Grasses and forbs food (cover)		Drinking water	
	Requirements	Supporting practice	Requirements	Supporting practice	Requirements	Supporting practice
Percentage of occurrence---	25-50% (10-35%)	Brush mgmt.	50-75% Open area with at least 50% of the potential vegetation	Brush mgmt. Deferred grazing Reseeding		
Distribution---	Minimum of 1/8 mile	Brush mgmt.	Well distributed	Proper grazing Reseeding Brush control	Every 2 miles	Ponds. Wildlife Watering facility.
Management condition----	No browse line (50% annual use)	Proper grazing. Livestock exclusive	50% annual use. Forbs at least 10% of annual production	Proper grazing. Grazing management systems Deferred grazing	Year round supply	Ponds. Wildlife Watering facility.

Vegetative type (or range site)--Pinyon-juniper
Wildlife Species--Mule deer, wild turkey, black bear, wide variety of nongame birds and mammals
Habitat elements--Evergreen trees, shrubs, native grasses and forbs, water (representative species cited)

Wildlife on Pasture

Status.--Pastureland is generally divided into (1) domestic pasture, which is land used primarily to produce adapted domesticated forage for livestock, and (2) native pasture, which is land used to produce native forage for livestock. In 1977, there were 115.9 million acres of domestic pasture in the United States excluding Alaska. This was 13.1 percent more than the 102.4 million acres in 1967. There were 17.7 million acres of native pasture in the United States in 1977.

Condition.--The amount of pastureland has clearly increased at the expense of forest land and cropland over the past 10 years. Converting land to pasture may be beneficial or detrimental to wildlife depending on: what the land is being converted from; the species composition of the pasture forage; the extent, size, and shape of the conversion unit; and the position of the pasture in relation to other habitat types.

When small grain cropland is converted to pasture, there is generally a loss in the waste grain and associated weed seeds eaten by wildlife such as quail, pheasant, and mourning doves. Depending on the quality of the cropland habitat, whether or not it provides adequate nesting and broad or protective cover along with waste grain and seeds, habitat may be degraded considerably when cropland is converted to pasture. Most cropland is converted to domestic pasture that is generally managed intensively to produce forage of a single or few species and grazed intensively during part of the year. Such pastures produce little wildlife habitat because the primary goal is forage production for livestock and the resulting management practices contribute little food and cover for most wildlife. Converting cropland to native pasture has a less unfavorable effect on wildlife since native pasture is generally less intensively managed and less frequently grazed. As a result, different cover components (bunch grasses, brush thickets, trees) often develop in native pasture. A variety of native forage species are generally present and provide diverse food and cover for wildlife. Depending on the quality of habitat on cropland, its conversion to native pasture may beneficially or adversely affect wildlife habitat.

Converting woodland to pasture may have an overall beneficial effect on wildlife habitat when small blocks are converted while trees or other habitat types are maintained along with the forage crop. In effect, diverse habitat can be created by converting woods to pasture by planning the size and shape of the grazing unit. Often wildlife will use forage if it is next to protective cover. This is especially true of grazing wildlife such as deer and elk in domestic pastures containing clovers or other palatable forage and in native pasture where forbs and preferred forage occur. The edge effect created by converting of woodland to pasture in small units also benefits many edge species.

The large scale conversion of any habitat type to pastureland has negative effects on nearly all wildlife species. Extensive tracts of intensively managed pasture where one or two forage species predominate have little value for wildlife.

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Section G-Windbreaks

Windbreaks help reduce soil blowing, conserve moisture, and protect crops, orchards, livestock, and buildings. They also control snow deposition, provide food and cover for wildlife, conserve energy, and increase the natural beauty of the landscape.

This section contains information on field windbreaks and farmstead and feedlot windbreaks.

Windbreaks were among the earliest conservation practices applied by the settlers in the Great Plains. The limited supply of timber, generally confined to narrow belts along streams, was soon exhausted. The settlers' need for trees for use as a source of construction material, food, fuel, fencing, and protection against a severe environment is documented as early as the 1840's and 1850's. Another important reason for planting windbreaks was the psychological benefits they provided settlers who had emigrated from the deciduous forests of the East (Droze, 1977).

The planting of windbreaks has been supported by various federal and state programs for more than 100 years. In 1873, the Timber Culture Act was passed. This Act offered homesteaders 160 acres of land if they would plant trees on 10 to 40 acres. Plantings were made until the Act was repealed in 1891.

After the repeal of the Timber Culture Act, federal programs continued to support tree planting in the Great Plains. Agricultural research and experiment stations conducted research programs and in 1887 the Hatch Act authorized federal funds for research by the land grant colleges. These cooperative research projects began to study the relationship of trees to soils and climate. They also studied ways to improve planting techniques for better survival. In addition, during the early 1900's forest nurseries began to make an appearance. One of the earlier nurseries was the Bessey Nursery established by the Forest Service near Halsey, Nebraska.

By the end of the first decade in the 1900's, most of the plains had been affected by the moldboard plow. The exposed soil surface and periods of extended drought created the right set of conditions for severe soil blowing. During the Dust Bowl days of the 1930's, massive wind erosion occurred and there was renewed emphasis on planting windbreaks. President Franklin Roosevelt authorized the Prairie States Forestry Project by executive order in 1934. Under this program the Works Project Administration and the Civilian Conservation Corps planted thousands of acres of trees. The program lasted 8 years and was very successful. The Prairie States Forestry Project ended in 1942.

Status

Area.--Windbreaks occupy approximately 1,405,000 acres (table 6G-1). Most have been planted on nonfederal land. Field windbreaks have been planted on more than 505,000 acres and farmstead and feedlot windbreaks have been planted on 900,000 acres. Table 6G-2 gives a breakdown of farmstead and

feedlot windbreaks and field windbreaks by state. (Field windbreaks are generally measured in miles. A conversion factor of 5 acres per mile is used to convert to acres.)

Table 6G-1.--Acres of windbreaks planted each year from 1966 to 1976 and the total planted to date

	Field windbreaks		Farmstead and feedlot windbreaks	
	Amount planted in year 1/	Total planted to date 2/	Amount planted in year 1/	Total planted to date 2/
	Miles	Miles	Acres	Acres
1966-----	3,717	79,743	31,029	634,803
1967-----	3,613	82,712	29,325	626,001
1968-----	3,921	86,498	28,893	630,309
1969-----	3,950	90,303	43,058	593,206
1970-----	3,559	87,450	42,580	774,756
1971-----	4,061	90,789	38,335	723,468
1972-----	3,364	92,911	43,180	742,342
1973-----	3,376	96,082	42,418	800,487
1974-----	2,577	99,031	45,880	808,183
1975-----	2,256	104,107	66,698	904,464
1976-----	2,260	101,016	50,083	900,330

1/ Source: Soil Conservation Service annual reporting system for conservation practices applied with SCS assistance.
2/ Source: Soil Conservation Service "99" report, based on SCS annual reporting system plus estimates of areas planted without SCS assistance and the amount of removals.

The total acreage planted to field windbreaks and farmstead and feedlot windbreaks does not accurately reflect the actual number of windbreaks that currently exist on the land. Some of the windbreaks have been removed. A more detailed discussion on removals follows in the "Condition" part of this section.

Species Planted.--The primary tree and shrub species being planted in windbreaks are eastern redcedar, green ash, Siberian elm, Russian-olive, Siberian peashrub, honeysuckle, ponderosa pine, and Austrian pine. There are 50 commonly used species of trees and shrubs planted in the Great Plains for windbreak purposes (Suedkamp, 1976).

In recent years, increasing numbers of conifers have been used in windbreaks. A 1977 SCS survey conducted in cooperation with the Great Plains Agriculture Council in the seven Great Plains States indicated that of all

Table 6G-2.--Acres of farmstead and feedlot windbreaks and miles of field windbreaks on the land in 1976

State	Farmstead and feedlot windbreaks	Field windbreaks
	(Acres)	(Miles)
Alabama	360	(1/)
Alaska	1,103	27
Arizona	363	54
Arkansas	----	29
California	18,021	717
Colorado	12,247	268
Connecticut	----	(1/)
Delaware	----	14
Florida	3	1,993
Georgia	----	6
Hawaii	147	300
Idaho	9,263	245
Illinois	5,947	197
Indiana	21,125	392
Iowa	78,980	168
Kansas	42,303	1,961
Kentucky	10	(1/)
Louisiana	----	(1/)
Maine	4,091	31
Maryland	11	5
Massachusetts	156	113
Michigan	25,290	2,554
Minnesota	84,579	8,371
Mississippi	231	57
Missouri	19,683	68
Montana	19,553	2,668
Nebraska	112,029	6,324
Nevada	1,452	33
New Hampshire	17	6
New Jersey	8,002	163
New Mexico	1,429	89
New York	33,104	193
North Carolina	12	307
North Dakota	114,688	60,150
Ohio	2,372	443
Oklahoma	1,711	400
Oregon	7,514	45
Pennsylvania	12,438	69
Rhode Island	------	1
South Carolina	------	233
South Dakota	210,859	9,531
Tennessee	------	(1/)
Texas	3,860	260

Table 6G-2.--Acres of farmstead and feedlot windbreaks and miles of field windbreaks on the land in 1976--Continued

State	Farmstead and feedlot windbreaks	Field windbreaks
	(Acres)	(Miles)
Utah------------------	1,132	25
Vermont---------------	------	(1/)
Virginia--------------	1,043	1
Washington------------	5,875	391
West Virginia---------	5,736	14
Wisconsin-------------	23,560	1,755
Wyoming---------------	10,031	342
Puerto Rico-----------	-----	3
Total------------	900,330	101,016

1/ Less than 1 mile.

Source: Soil Conservation Service "99" report, based on SCS annual reporting system plus estimates of areas planted without SCS assistance and the amount of removals.

the trees and shrubs planted, 50 percent were conifers, 25 percent were broadleafs, and 25 percent were shrubs (table 6G-3).

Table 6G-3.--Tree and shrub planting stock used in the Great Plains in 1977

State	Conifers	Broadleafs	Shrubs	Total
		(Thousands)		
Colorado	415	243	144	802
Kansas	630	319	294	1,243
Montana	835	118	385	1,338
Nebraska	2,198	241	195	2,634
New Mexico	41	60	12	113
North Dakota	1,037	1,059	1,035	3,131
South Dakota	773	978	864	2,615
Total	5,929	3,018	2,929	11,876

Source: Great Plains Agricultural Council Publication No. 85 (1977).

Condition

Renovation.--Many of the older windbreaks, particularly those planted during the Prairie States Forestry Projects, are in need of some form of renovation. Renovation means applying those silvicultural practices that will restore or create proper spacing, density, structure, and species composition to provide the desired level of protection (Van Deusen, 1976). Some windbreaks are reaching maturity and losing their effectiveness. Others are overcrowded, which suppresses some species and causes others to die. Damage by insects, disease, and livestock and poor matching of planting stock with soils and climate are other important reasons for renovation.

Removals.--The removal of windbreaks, particularly in the Great Plains, has been a matter of public concern in recent years. The Comptroller General was asked to look into this situation on June 20, 1975. The General Accounting Office (GAO) issued a report on its findings. Based on a survey in several counties in Kansas, Nebraska, and Oklahoma, the GAO concluded that actions were needed to preserve windbreaks in the Great Plains (GAO, 1975).

Landowners gave a number of reasons for removing windbreaks. Some of the major reasons were: 1) they take up too much space that is needed for crop production; 2) they interfere with the installation of pivot irrigation systems; 3) they are no longer effective; 4) the need to realign field boundaries; 5) high taxes; and 6) trees have been damaged by insects, disease, livestock, and chemicals.

In response to the GAO report, the Soil Conservation Service conducted an inventory of windbreak removals. Five states were sampled -- North Dakota, South Dakota, Nebraska, Kansas, and Oklahoma. SCS made comparisons between 1970 and 1975 using remote sensing techniques (USDA, 1979). This inventory indicated that: 1) farmstead and feedlot windbreaks are not being removed; 2) the number of field windbreaks is increasing; 3) the area of field windbreaks is decreasing slightly; 4) the total length of field windbreaks is increasing; and 5) the number of wide field windbreaks is decreasing and the number of narrow field windbreaks is increasing (table 6G-4).

Trends

Area.--The total area planted to field and farmstead and feedlot windbreaks has shown a steady increase in the past four decades. In the period 1966 to 1976, the average number of miles of field windbreaks planted annually was 3,300 miles, and the average annual planting of farmstead and feedlot windbreaks nearly 42,000 acres (table 6G-1).

This steady increase in the miles and acreage of windbreaks is expected to continue. Yearly variations in the amount of windbreaks planted are due in part to unfavorable planting conditions and the availability of planting stock.

There has been a significant shift by landowners to using fewer rows of trees in their windbreaks, particularly field windbreaks. Many of the earlier windbreaks planted in the 40's and 50's had 8 to 12 rows and some as many as 20 rows. Field windbreaks planted in recent years are using one to five rows.

Renovation.--There has been a definite trend toward renovation of older windbreaks in the past several years. Federally assisted cost-share programs have been a major factor in stimulating the interest in this conservation practice.

Removals.--A number of the older multirow windbreaks have been removed. These losses are more than offset by the planting of new windbreaks. It is expected that a certain amount of removal will continue as the older windbreaks reach their biological maturity or lose their effectiveness because of damage caused by insects, disease, or lack of maintenance.

Table 6G-4.--Summary of statistics on field windbreak removals for five Great Plains States, 1970 and 1975

State	Number		Acres		Miles	
	1970	1975	1970	1975	1970	1975
North Dakota-----	53,437	55,887	101,635	101,573	21,569	22,546
% of total-----	45.6	46.5	35.8	36.6	56.8	58.3
South Dakota-----	13,546	13,463	48,513	47,789	3,808	3,778
% of total-----	11.6	11.2	17.1	17.2	10.0	9.8
Nebraska---------	32,630	32,908	84,159	79,484	7,661	7,455
% of total-----	27.8	27.4	29.7	28.6	20.2	19.3
Kansas-----------	12,975	13,397	34,677	34,948	3,521	3,521
% of total-----	11.1	11.2	12.2	12.6	9.3	9.1
Oklahoma---------	4,594	4,414	14,722	14,155	1,443	1,384
% of total-----	3.9	3.7	5.2	5.1	3.8	3.6
Total-------	117,182	120,069	283,706	277,949	38,002	38,684
Change-----------		+2,887		-5,757		+682
% change from 1970--------		+2.5		-2.1		+1.8

Source: Soil Conservation Service, Field Windbreaks -- A Status Report for Five Great Plains States (USDA, 1979).

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Participation in Outdoor Recreation

At the present time, there are no national data that specifically relate outdoor recreation directly to the Nation's nonfederal forest, range, crop, and pasture lands. There are some relevant preliminary findings, however, in the Nationwide Outdoor Recreation Assessment, which is part of the Nationwide Outdoor Recreation Plan being developed by the Heritage Conservation and Recreation Service. The Forest Service's preliminary findings in its assessment for the Forest and Rangeland Renewable Resources Planning Act (RPA) are also timely and helpful.

One of the key elements in the Nationwide Outdoor Recreation Assessment is the 1977 National Outdoor Recreation Survey. This survey was conducted primarily to determine those outdoor recreation activities in which people participate, those in which they would like to participate, the frequency of participation, and the factors that influence participation.

As in previous national recreation surveys, people said they participated most in picnicking, sightseeing, swimming, walking for pleasure (including jogging), driving for pleasure, and fishing (table 6H-1).

Table 6H-1 shows the base levels of participation in outdoor recreation by activity for the Nation as a whole. The first column of this table ranks the recreation activities in which most Americans 12 years of age or older participate at least once a year. Regular participation (five or more times during the year) in a recreation activity produces a different ranking order, as shown in the second column in the table. This is probably a more reliable ranking since it tends to offset the effects of occasional or one-time participation.

Based on the percentage of people who stated that they had participated in an activity for the first time during the previous year, the fastest growing outdoor recreation activities are cross-country skiing; downhill skiing; tennis; sailing; snowmobiling; waterskiing; canoeing, kayaking, or river-running; golf; driving off-road vehicles or motorcycles; and horseback riding. As indicated by the percentage of people who said they would like to begin participating in an activity during the "next year or two," the 10 activities with the highest growth potential are: downhill skiing; tennis; waterskiing; horseback riding; cross-country skiing; camping in primitive areas; sailing; golfing; snowmobiling; and canoeing, kayaking, or river-running.

The 1977 National Outdoor Recreation Survey shows significant differences between participation in recreation in various regions of the country. More westerners participated in camping, backpacking, and skiing than residents of other regions. Northerners participated more frequently than westerners in certain snow and ice activities such as ice skating, snowmobiling, and sledding. They also went swimming and canoeing more often. Southerners, on the other hand, participated as often or more often than westerners in waterskiing, driving for pleasure, hunting, and fishing (USDA, 1978).

Table 6H-1.--Participation in selected outdoor recreation activities by people 12 years and older, 1977 1/

Recreation activity	Percentage participating at least once a year	Percentage participating five or more times yearly
Visits to amusement parks, zoos, aquariums, fairs, etc.	73	39
Picnicking	72	49
Driving for pleasure	69	57
Walking or jogging	68	57
Pool swimming and sunbathing	63	49
Sightseeing	62	36
Attending sports events	61	44
Playing outdoor sports or games	56	43
Fishing	53	36
Nature walks, bird-watching, or wildlife photography	50	36
Bicycling	47	39
Nonpool swimming and sunbathing	46	35
Attending dances, concerts, or plays	41	22
Boating (not including sailing or canoeing)	34	20
Tennis	33	24
Camping in developed areas	30	12
Hiking or backpacking	28	16
Use of off-road vehicles or motorcycles	26	20
Camping in primitive areas	21	9
Sledding	21	12
Hunting	19	14
Canoeing, kayaking,or river-running	16	5
Waterskiing	16	8
Golfing	16	11
Ice skating	16	9
Horseback riding	15	8
Sailing	11	5
Snowmobiling	8	5
Downhill skiing	7	4
Cross-country skiing or ski touring	2	1

1/ According to the U.S. Census Bureau, the U.S. population 12 years and older was 174.4 million as of July 1, 1976.

Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service, 1977 National Outdoor Recreation Survey. (USDI, 1978)

The Demand for Outdoor Recreation

Traditional economics cannot be used to estimate the future demands for outdoor recreation because of the absence of a well defined market system. However, the Forest Service has recently completed a series of long-range estimates of recreation participation extending to the year 2030. These projections use the expected number of participants as an index of the future quantity of facilities that will be needed. To estimate future demand, the Forest Service used a cross-sectional regression analysis of the 1977 National Outdoor Recreation Survey based on population and other projections of the Bureau of the Census and the Office of Federal Statistical Policy Standards.

Demand Projections.--As indicated in table 6H-2, the Forest Service projections indicate that participation will grow considerably in all of the activities studied. But the size of the projected increases differs substantially. Between now and the year 2030, the Forest Service expects the greatest increases in participation in sailing, downhill skiing, crosscountry skiing, saltwater fishing, ice skating, canoeing, developed and primitive camping, and sledding. Because of factors such as climate, terrain, and the migration to the "sunbelt" states, there will be variations from region to region in participation in individual types of outdoor recreation.

The Supply of Outdoor Recreation

Of the approximately 2.4 billion acres of land and water area in the United States, approximately 1.5 billion acres are in nonfederal ownership. Of this amount, about 1.4 billion acres are privately owned.

Only a small proportion of the 1.5 billion acres of nonfederal land is intensively managed for recreation, although recreation is frequently a secondary use of these lands. Where recreation is the primary land use, it is usually in state, regional, and local parks and in developed recreation sites such as picnic and athletic areas and campgrounds.

Nonfederal Public Land

State Land.--The 50 states own nearly 78 million acres of land and water that are used for recreation and to preserve open spaces (USDI, 1978). The largest recreational acreages are state forests (26.5 million acres), fish and wildlife areas (9.0 million acres), and parks (5.5 million acres). See table 6H-3.

Of the 26.5 million acres of state forests, 21.4 million acres are located in the northeastern and north central states. Noteworthy examples of state forest are the Adirondack (2.5 million acres) and Catskill (259,000 acres) State Parks in New York, and Baxter State Park (200,000 acres) in Maine. State lands in the North more than double the per capita availability of public land, increasing the figure to 0.3 acres per person, up from 0.1 acres per person from federal land alone (USDI, 1978).

Table 6H-2.--Indices of the projected demand to 2030 for outdoor recreation in the conterminous states shown by activity group and type of activity. The base year is 1977 (1977=100).

Activity group and type of activity	Year					
	1977	1990	2000	2010	2020	2030
	(Percentages of 1977 demand)					
Land:						
Camping (developed)-------	100	126	150	181	214	245
Camping (dispersed)-------	100	116	133	157	182	205
Driving off-road vehicles-	100	108	118	129	139	148
Hiking-------------------	100	109	117	132	146	159
Horseback riding----------	100	109	118	139	159	181
Hunting (big game)--------	100	114	125	134	142	148
Hunting (small game)------	100	106	113	118	121	124
Hunting (waterfowl)-------	100	119	133	148	160	169
Nature study--------------	100	110	121	133	145	155
Picnicking----------------	100	112	124	137	150	162
Pleasure driving----------	100	108	116	126	135	143
Sightseeing---------------	100	112	123	136	150	163
Water:						
Canoeing------------------	100	121	141	175	209	249
Fishing (freshwater)------	100	118	139	157	174	190
Fishing (saltwater)-------	100	130	162	193	225	256
Sailing-------------------	100	145	185	239	298	367
Other boating-------------	100	119	137	163	189	220
Swimming (outdoor)--------	100	115	127	147	168	190
Waterskiing---------------	100	109	118	140	161	185

Table 6H-2.--Indices of the projected demand to 2030 for outdoor recreation in the conterminous states shown by activity group and type of activity. The base year is 1977 (1977=100)--Continued

Activity group and type of activity	Year					
	1977	1990	2000	2010	2020	2030
	(Percentages of 1977 demand)					
Snow and ice:						
Cross-country skiing-----	100	133	161	200	241	280
Downhill skiing----------	100	142	179	232	289	352
Ice skating--------------	100	123	144	177	212	250
Sledding-----------------	100	118	133	163	193	227
Snowmobiling-------------	100	109	120	141	161	181

Sources: U.S. Department of Agriculture, Forest Service. An Assessment of the Forest and Range Land Situation in the United States (in process). Dyer, A.A., and W. E. Wegert. 1978. Demand Analysis and Projections of Use for Hunting and Fishing Opportunities. M.S. Dissertation. College of Forestry and Natural Resources, Colorado State Univ., Fort Collins.

States reported that their parks were visited more than 565 million times in 1975, which was an increase of 45 percent over the number of visits made in 1967 (National Association of State Park Directors et al., 1977). This level of annual visits was second only to the level for municipal parks and recreation facilities, and it exceeded the total for national parks and forests.

Table 6H-3.--State public lands by use and acreage, 1977

Use	Acreage
Forests	26,503,389
Fish and wildlife areas	9,005,445
Parks	5,528,030
Subtotal	42,036,864
School land	430,807
Unclassified	36,400,000
Total	77,867,671

Source: U.S. Department of the Interior, Bureau of Land Management. Public Land Statistics, (USDI, 1977).

Although most wilderness areas are on federal land, state and local governments also have set aside wilderness areas. Nine states have established wilderness systems within their boundaries. Other public lands could also be designated as wilderness. New York State has designated about 1 million acres as wilderness in 16 areas (USDA, 1978).

Many states are also working on trail systems to complement the National Trails System established by Congress in 1968. Trails provide opportunities for low-density, dispersed types of recreation such as hiking, biking, and horseback riding. With relatively little expense for acquisition, trails can be established along rivers, canals, streams, railroad lines, and utility rights-of-way.

Since there is no common denominator for classifying state and local lands, it is difficult to fully assess their national impact on outdoor recreation. Some states lease federal lands and manage them as state parks or forests. In some states, state parks are managed only for recreation and resource preservation. In others, state parks and forest are managed for both forest products and for recreation with no distinction made between the two systems. Some states own land that has no managerial classification. For example, as a result of the Statehood Act, Alaska has 36.4 million acres in state ownership (nearly half of the Nation's total) with no classification as to its use. State forests are generally managed for multiple uses such as timber production, maintenance of water supplies, and preservation of wildlife as well as for recreation. Three states have nearly a half million acres of

lands that they hold in trust for school systems and simply retain for future use.

Most state parks and other public recreation lands are not presently included in local soil and water conservation districts. Although statistical data are lacking, there are indications that many such areas are deteriorating, frequently because of overuse, and that they are among the major sources of erosion and sedimentation in some areas. Since conservation district work has been focused mostly on private land, the extent of this problem on non-federal lands has largely been unrecognized.

Local Land.--The park and recreation acreage provided by local governments (cities, towns, counties, districts, regions, and subdivisions of state governments) is nearly 11 million acres (USDI, 1973). While this is considerably less than the acreage administered by federal or state governments, the majority of recreation activity days are provided at the local level.

Epperson (1977) indicated that a total of 491 million acres of public land are available for recreation in the United States. These public lands consist of about 65,000 individual areas of all sizes that provide a significantly large number and variety of opportunities for recreation.

Epperson points out, however, that availability is not necessarily accessibility. Almost one-half of the Nation's population lives in the northeast quadrant. But the recreation lands in the West constitute more than 75 percent of the available land and the West has only 17 percent of the Nation's population. The 1973 Nationwide Recreation Plan (USDI, 1973) indicates that only 25 percent of the recreation facilities and only 3 percent of the public recreation lands are reasonably available in the area where 75 percent of our population is concentrated.

Private Land.--The private sector plays an important role in providing recreation facilities. Nationally, private and nonprofit recreation facilities and areas account for two-thirds of all areas devoted to recreation (USDI, 1978). Without private recreation lands and facilities, the demand on public areas would be overwhelming. Officials of public agencies are beginning to realize that their agencies cannot begin to supply the total recreation needs of the American public. They recognize the need to cooperate, plan, and develop recreation areas jointly and with the private sector, and the need to assist each other to avoid unnecessary duplication, unfair competition, or an imbalance of supply and demand.

The more than 700 million acres of corporate and noncorporate private forest and rangelands in the United States have enormous potential for public recreation use. (Corporate lands are those owned by business and noncorporate lands are those that are not.) About 32 percent of the noncorporate and 59 percent of the corporate acreages of forest and range are now open to the public for recreation. An additional 31 percent of the noncorporate land and 13 percent of the corporate land are currently available to employees or special groups for recreation through leases or other arrangements. While not available to the general public, this leased land is open to a large number of persons for outdoor recreation and it is an important part of the national supply of private recreation land (Cordell et al., 1978).

The private forest and rangeland in the United States is a substantial base for outdoor recreation, especially in the East where 90 percent of this land is located. Fifty-three percent of the 69 million acres of corporate lands is in the southeastern and south central states. An important 19 percent of this corporate land is in the more densely populated northeast. Of the Nation's 672 million acres of noncorporate private forest and range lands, 66 percent is in the south central, Rocky Mountain, and Great Plains regions.

While the average size of the individual private estate is more than 800 acres, 75 percent of the rural landowners have tracts smaller than 500 acres. Recreational lots and vacation homes are a large segment of these privately owned lands. About 6 million acres of land (7.5 million lots in 6,000 recreation land projects) fall into this category (USDI, 1978). In 1977, there were about 3.5 million vacation homes that were owned by slightly more than 5 percent of all households.

Various nonprofit groups such as the Nature Conservancy have successfully fostered donations and bargain sales of thousands of acres of private recreation lands for public use.

While many opportunities exist for public recreation on privately owned land and water, recent studies indicate that there is very little active management of these resources for recreation. Most of the public recreation on private lands takes place through passive permission. Many landowners are unwilling to open their lands for public recreation under any circumstances. Many problems must be addressed before more of the recreational potential of private lands can be realized. The basic root of these problems is that almost all owners of private lands have objectives or primary uses other than recreation. In fact, recreation as a primary use objective on private lands is practically nonexistent. Another root of these problems is the apparent low profit potential in many forms of recreation.

In 1978, private landowners were asked about their policies on public use of their lands and the reasons for them. Table 6H-4 shows the results of that survey. The reasons cited most often for keeping lands closed are the belief that public recreation is incompatible with the current land use and the concern about vandalism and liability.

On private lands open to the public, the most common attractions are lakes or streams, picnic sites, campgrounds, designated hunting areas, and roads. With the exception of campgrounds, picnic grounds, and recreation access roads, these attractions occur naturally or serve primary purposes other than recreation. Among owners with land open to the public, only about 10 percent provide any facilities or amenities, either free or for a fee. Because development is not extensive, approximately 90 percent of the private lands open for recreation remain in a largely forest or farm-like state.

The survey shows that most owners have no plans to develop additional facilities for the public. This reflected the fact that only 9 percent of the landowners with open lands expected to earn income from public use of their land. More than 95 percent of the landowners whose lands are now closed to public recreation said they did not plan to open their lands under any conditions during the next 5 years. Some landowners and managers would

Table 6H-4.--The policies of private landowners on public use of their land (1978)

Open for public use			Not open for public use		
	Percentage of owners			Percentage of owners	
Reason for policy	Noncorporate	Corporate	Reason for policy	Noncorporate	Corporate
Helps public relations----	33.0	57.4	Preserves privacy---------	22.3	10.8
Too much trouble to close or post----------------	22.8	15.4	Interferes with current use--------------------	17.6	30.0
Provides income----------	8.0	3.7	Reduces vandalism----------	14.4	15.4
Reduces vandalism---------	6.2	2.1	Protects wildlife----------	9.9	6.2
Part of multiple use plan-	5.4	9.0	Avoid lawsuits------------	8.5	7.7
Public pressure to use----	3.6	3.7	Prevents fires and garbage-	7.9	9.2
Required by law----------	0.9	3.2	Land not suitable for use--	6.9	4.6
Avoids condemnation-------	0.4	1.6	Preserves beauty----------	5.7	2.3
Other--------------------	19.6	3.7	No demand for use----------	2.0	1.5
			Never thought of it------	0.5	0.8
			Other-------------------	4.3	11.5

Source: Cordell, H. K., M. H. Legg, R. W. McLellan, The Private Recreation Estate. Forest Service, U.S. Department of Agriculture. Unpublished. (1978)

consider opening more land if a profit could be made, if they received adequate tax incentives, and if they could be assured that they would not be financially liable for injuries or losses incurred by recreation on their land. Other problems in opening land to the public are lack of managerial expertise, insuffcent capital or credit to upgrade or provide basic visitor facilities, and lack of adequate data on cost versus return.

o Inventory of Private Recreation Areas and Facilities.--Between 1974 and 1976, the National Association of Conservation Districts (NACD) conducted a nationwide (excluding Texas) county-by-county inventory of private recreation areas and facilities. The NACD was assisted by the Soil Conservation Service, the Extension Service, the Bureau of Outdoor Recreation (now the Heritage Conservation and Recreation Service), and a number of other agencies and organizations. The survey attempted to (1) assess the number and location of both profit and nonprofit enterprises and (2) assess the types of activities and facilities offered at each enterprise. The inventory identified more than 71,000 recreation enterprises in 17 different categories of primary facilities, ranging from campgrounds to water sports areas, from tennis to rockhounding. Over 62 percent of the enterprises inventoried were "private for profit." The others were "private and semiprivate nonprofit." Table 6H-5 shows the types and numbers of enterprises by primary facility. The nationwide summary of all the activities and facilities inventoried is shown in table 6H-6.

In the late 1960's and early 1970's the Soil Conservation Service helped local conservation districts conduct appraisals in more than 80 percent of the counties in the United States to assess the potential for developing outdoor recreation. The appraisals were essentially the group conclusions of resource professionals and citizens on the physical potential of a county for future development of recreation areas and enterprises. The appraisals, however, did not provide estimates of needs or market analyses.

The Fish and Wildlife Service estimated that in 1975, 20.6 million hunters over 9 years of age participated in 478.6 million days of hunting in the United States. More than 60 percent of all hunting and 76 percent of small game hunting took place on private land. Of the $5.8 billion spent by these hunters, more than $27.3 million was spent on access fees for use of private lands.

o Campgrounds and Camps.--There were 964,826 campsites in the United States in 1975. About 58,000 of these were privately owned (USDI, 1978). Camping has become one of the fastest growing outdoor recreational activities, and there has been strong pressure to develop more camping facilities.

In recent years, there have been complaints that governments at all levels have competed unfairly against the private sector in providing campgrounds to the public. As a result, some public agencies have modified their practices and no longer provide such amenities as full water and electrical hookups, but leave such refinements to the private sector. Generally, public campgrounds place greater emphasis on scenic and natural qualities, while private campgrounds provide more conveniences. In 1977, three-fourths of all private sites had electricity (Woodall, 1977) and one in ten had water at each site.

Table 6H-5.--Private profit and nonprofit recreation enterprises in the United States, by primary facility, 1977

Enterprises (Primary facilities)	Profit	Nonprofit	Total
Campgrounds	10,325	4,808	15,133
Field sports	770	2,914	3,684
Fishing waters	6,066	3,878	9,944
Golfing facilities	5,536	3,277	8,813
Historical/archaeological sites	333	972	1,305
Hunting areas	1,997	3,406	5,403
Natural scenic areas	316	744	1,060
Picnic areas	407	1,194	1,601
Racetracks	1,018	252	1,270
Recreation resorts	4,197	248	4,445
Rockhounding areas	77	12	89
Rodeo, zoo, amusement parks	2,444	956	3,400
Shooting preserves	574	880	1,454
Snow ski areas	446	77	523
Trails	2,121	601	2,722
Vacation farms	712	53	765
Water sports	7,017	2,855	9,872
Totals	44,356	27,127	71,483

Note: Includes figures from Puerto Rico, the Virgin Islands and Washington, D.C. Texas did not participate in the inventory.
Source: National Association of Conservation Districts. Inventory of Private Recreation Facilities - 1977 (NACD, 1977)

Table 6H-6.--The National Association of Conservation Districts' inventory of recreation activities and enterprises provided by the private sector in the U.S. 1977 1/

Type of activity	Amount of measured units			Number of enterprises: Profit	Nonprofit	Total
Camping						
Canoe	198,556 areas	--------------	----------------	261	131	392
Day	271,440 acres	492,834 guests	----------------	904	1,322	2,226
Pack	43,436 areas	--------------	----------------	362	238	600
Resident	964,839 acres	2,691,421 guests	----------------	2,616	3,038	5,654
Transient	235,198 acres	272,953 vehicle sites	199,116 tent sites	3,693	458	4,151
Vacation	635,789 acres	613,980 vehicle sites	339,276 tent sites	7,326	924	8,250
Archery	208,280 ranges	20,591 positions	----------------	947	1,505	2,452
Shooting range	338,667 positions	---------------	----------------	1,041	2,263	3,304
Tennis	27,430 courts	---------------	----------------	2,020	2,406	4,426
Fishing - ponds/lakes	2,167,190 acres	51,762 ponds/lakes	----------------	7,660	5,016	12,676
Fishing enterprises	3,936,668 acres	58,953 enterprises	----------------	5,940	667	6,607
Golf - driving	421,658 acres	525,649 positions	----------------	1,589	518	2,107
Golf						
Executive	346,299 acres	6,710 holes	----------------	387	185	572
Miniature	7,799 acres	23,419 holes	----------------	1,378	98	1,476
Par 3	323,067 acres	8,348 holes	----------------	574	131	705
Regulation	2,553,353 acres	145,955 holes	----------------	3,880	3,043	6,923
Historical/archaeological	405,457 acres	14,424 sites	----------------	584	1,016	1,600
Hunting - total area	37,507,290 acres	-------------	----------------	2,816	3,970	6,786
Hunting	33,226,439 big game acres	24,535,294 small game acres	1,952,198 water fowl acres	4,495	6,068	10,563

Table 6H-6.--The National Association of Conservation Districts' inventory of recreation activities and enterprises provided by the private sector in the U.S. 1977 1/--Continued

Type of activity	Amount of measured units			Number of enterprises		
				Profit	Nonprofit	Total
Natural/scenic	951,095 acres	104,955 road miles	--------------	1,395	1,277	2,672
Picnicking	1,121,267 acres	930,885 tables	--------------	5,443	4,469	9,912
Racing - viewing	572,749 acres	5,833,364 spectators	222,516 track miles	1,088	296	1,384
Recreation resort	1,131,917 acres	866,011 guests	--------------	3,234	172	3,406
Rockhounding	253,708 acres	558,198 guests	--------------	273	59	332
Rodeo/zoo/amusement park	283,627 acres	--------------	--------------	2,671	1,016	3,687
Shooting preserve	2,308,970 acres	--------------	--------------	537	895	1,432
Snow skiing	325,733 acres	1,488,199 persons/hour	--------------	1,104	161	1,265
Trails - total	58,292 miles	--------------	--------------	3,691	1,935	5,626
Bicycle	105,623 miles	5,041 rentals	--------------	626	181	807
Hiking	65,385 miles	--------------	--------------	2,868	2,411	5,279
Horse	138,427 miles	154,307 rentals	191,451 boarded	3,316	582	3,898
Off-road vehicles	807,101 acres	6,082 miles	--------------	515	149	664
Snowmobiling	1,657,343 acres	448,281 miles	--------------	833	461	1,294
Vacation farm	83,732 acres	10,916 guests	--------------	573	14	587
Vacation ranch	592,984 acres	24,833 guests	--------------	450	22	472
Boating						
Nonmotor	31,867 canoes	105,408 sail	53,322 other	6,224	1,192	7,416
Motor	7,701 charter	135,060 rentals	--------------	4,821	332	5,153
Launch and storage	370,447 boats	12,167 ramps/lanes	313,331 boat slips	11,707	2,250	13,957
Swimming	3,050,489 linear ft. beach	182,419 acres - pond	26,692,241 sq. ft.-pool.	12,227	7,152	19,379

1/ Includes figures from Puerto Rico, the Virgin Islands, and Washington, D.C. Texas did not participate. Source: National Association of Conservation Districts. Inventory of Private Recreation Facilities - 1977 (NACD, 1977)

In 1976, the use of recreational vehicles in camping had surpassed the use of tents. The tent camper generally requires a site offering water, sanitary facilities, a table, and a fireplace. Recreational vehicles require a parking space, waste disposal, refills of fuel and water, and usually an electrical hookup.

There were 15,852 campgrounds listed in the 1977 Rand McNally Campground and Trailer Park Guide. The private sector supplied most of the campgrounds in the North and South, while the public sector supplied the most in the Rocky Mountain and Pacific Coast States. Of the public facilities, the Forest Service supplied 43 percent; states provided 26 percent; local governments 10 percent; and the National Park Service 5 percent.

Water Related Recreation

Many types of outdoor recreation depend directly upon water, such as swimming, fishing, boating, waterskiing, and ice skating. Other activities, such as picnicking and camping, are greatly enhanced by the proximity of water.

The Water Resources Council has estimated that about one-fourth of all outdoor recreation depends on water and that about two-thirds of all publicly administered recreation areas either have a body of water within their boundaries or are adjacent to accessible water.

Water-related recreation continues to grow in popularity. The U.S. Coast Guard reported that there were about 12.7 million recreational boats in the United States in 1976, an increase of 3 million since 1973. The Coast Guard also indicated that the ownership of kayaks increased 107 percent between 1973 and 1976 (USDA, 1978).

One factor that has increased the interest in outdoor recreation on water has been the reduction of pollution in many waterways. Reduced water pollution is an objective of both the Water Quality Act of 1965 and the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). Pollution abatement has improved the opportunities for recreation on water, particularly near urban areas.

Supply.--States have attempted to define their water resources in statewide outdoor recreation plans. The inventory data from these plans, however, are frequently based on varying assumptions and definitions. Consequently, the data cannot readily be aggregated. Data on supplies seldom reflect the suitability of the water for different recreational activities.

The Water Resources Council estimated in its Second National Water Assessment that in 1975 Americans engaged in water-dependent activities such as swimming at beaches, boating, canoeing, fishing, sailing, and waterskiing nearly 1.4 billion times. They engaged in water-enhanced recreation (picnicking and camping) 663 million times in 1975 (table 6H-7). The total number of times that people engaged in water-related activities was more than 2 billion; about 68 percent of these were water-dependent and 32 percent water-enhanced. Of the total number of times that people engaged in water-dependent activities, they went swimming at beaches 43 percent of the time, sport

Table 6H-7.--Estimated water-related outdoor recreation activity occasions, by water resource regions -- 1975, 1985, 2000 (million activity occasions)

Water resources region and number	Water-dependent			Water-enhanced		
	1975	1985	2000	1975	1985	2000
New England (1)-----------	69.8	77.9	91.0	35.7	40.9	48.4
Mid-Atlantic (2)----------	217.9	246.6	289.3	115.0	131.0	155.9
South Atlantic-Gulf (3)---	160.5	192.0	235.1	57.9	68.4	85.3
Great Lakes (4)-----------	220.4	247.1	295.0	106.6	119.1	138.7
Ohio (5)------------------	142.1	158.3	182.8	58.9	65.5	75.5
Tennessee (6)-------------	22.5	26.4	31.9	8.0	9.4	11.3
Upper Mississippi (7)-----	97.3	112.0	126.4	47.6	53.0	61.4
Lower Mississippi (8)-----	40.7	44.3	49.4	14.5	15.8	17.5
Souris-Red-Rainy (9)------	4.7	4.7	4.8	2.3	2.3	2.3
Missouri (10)-------------	61.9	67.5	77.2	32.8	35.7	40.8
Arkansas-White-Red (11)---	44.5	48.6	55.8	18.0	19.7	22.2
Texas-Gulf (12)-----------	62.6	73.1	89.2	22.3	26.0	31.7
Rio Grande (13)-----------	10.7	11.7	13.1	5.9	6.5	7.3
Upper Colorado (14)-------	2.2	2.3	2.6	1.4	1.5	1.7
Lower Colorado (15)-------	15.4	19.2	25.4	9.8	12.3	16.3
Great Basin (16)----------	8.0	9.7	12.2	5.2	6.2	7.8
Pacific Northwest (17)----	42.7	46.1	53.1	27.4	29.6	34.0
California (18)-----------	134.8	156.6	189.5	86.4	100.4	121.3
Total, Regions 1-18--	1,358.7	1,544.0	1,823.7	655.7	743.3	879.4
Alaska (19)---------------	2.0	2.4	3.1	1.3	1.5	2.0
Hawaii (20)---------------	18.2	20.8	25.6	5.9	6.6	8.0
Caribbean (21)------------	N/A 1/	N/A 1/	N/A 1/	N/A 1/	N/A 1/	N/A 1/
Total, Regions 1-20--	1,378.9	1,567.2	1,852.4	662.9	751.5	889.4

1/ N/A = data not available.

Source: U.S. Water Resources Council. The Nation's Water Resources, 1975-2000. Volume 1: Summary. December 1978.

fishing 28 percent of the time, and boating 20 percent. The remaining 9 percent of the total times was devoted to waterskiing (5 percent), and sailing and canoeing (about 2 percent each). The number of times the population engaged in water-enhanced activities was split between picnicking (83 percent) and camping (17 percent). Swimming, boating, and waterskiing are more popular in western areas, while fishing, canoeing, boating, and sailing are more frequent activities in eastern areas.

According to the Water Resources Council, there are about 20.3 million acres of surface water accessible and usable for recreation in the conterminous United States (Water Resource Regions 1-18), or about 122 acres per 1,000 people who are 12 years of age or older. However, this surface water area available for recreation is only about one-fourth of the total area of surface water, which is nearly 84.6 million acres. The remaining 64.3 million acres of potential water area for recreation are now inaccessible, polluted, or otherwise restricted from recreational use. The Council estimated that to meet recreation demands the Nation needed 8 million more acres of water surface in 1975 and would need 10 million more acres in 1985 and 13 million more acres in 2000. These needs may be met partially by removing restrictions on access to existing water bodies, improving water quality, and reducing competitive uses.

The availability of surface water that can be used for recreation varies from a low of about 10 percent in the Great Lakes Region (excluding the Great Lakes themselves) to a high of 86 percent in the Great Basin Region. There are several reasons why such a low percentage of surface water is available for recreation in some regions. The size of the water bodies alone precludes much of the Great Lakes and some coastal waters from recreational use. This limitation is often intensified by the lack of adequate harbors, launching facilities, and other support facilities and by unfavorable weather conditions. Poor water quality in urban and rural areas has made large portions of the Nation's streams and lakes unusable for certain types of recreation. Sedimentation, shoreline development, eutrophication, and limited access often limit the use of inland lakes and reservoirs for recreation.

Aquatic vegetation, parasites, and vectors limit the use of water for recreation, especially in the South. In areas where there is a limited supply of surface water, recreation is limited by competing noncomplementary uses.

The Water Resources Council also stated that it expects the demand for water recreation in streams to grow by about 35 percent between 1975 and 2000. In several water resource regions (especially the Mid-Atlantic, Great Lakes, and Missouri) stream-mile requirements for recreation in the year 2000 will meet or exceed the available stream miles for recreation unless stream water quality and access are improved and constraints on recreation uses of streams are reduced. (USWRC, 1978).

o Rivers and Streams.--Rivers and streams are increasingly important in water-related recreation. A wide variety of water-based recreation can take place along rivers and streams. In a few places where water is still clean, people can go swimming, as well as go fishing and boating. Smaller streams provide unique opportunities for whitewater rafting, kayaking, and canoeing.

Most rivers have an even broader recreational appeal because of their scenic qualities and they provide desirable settings for camping, hiking, picnicking, and other land based activities.

In the 1977 National Resource Inventories, the Soil Conservation Service identified more than 2 million acres of surface water that were used primarily for recreation and fish and wildlife in streams less than one-eighth mile wide.

There are about 260,000 miles of streams in the conterminous United States that are available for recreation use of which 29 percent is of limited use because of poor water quality. (USWRC, 1978). There are other constraints on the use of these streams such as low flows but there are no data on the extent to which they limit recreation.

In 1968 Congress established a policy intended to preserve selected river segments in their free-flowing condition. The Wild and Scenic Rivers Act declared that rivers and their immediate environs that possess outstanding scenic, recreational, geologic, fish and wildlife, historic, cultural, and other values should be preserved for the benefit and enjoyment of present and future generations.

Eight rivers were included in the Wild and Scenic Rivers Systems by the original Act and Congress identified 27 others to be studied for possible inclusion. Since 1968, 20 river segments have been added to the system and 31 others have been authorized for study. Six states have portions of rivers totaling 245 miles included in the national system, which altogether has 2,317 miles of river. Twenty-four states also adopted their own river protection systems. These systems include almost 6,000 miles, but in some states designation is little more than symbolic.

The Heritage Conservation and Recreation Service is surveying and assessing the Nation's rivers to identify potential wild, scenic, and recreation areas for possible conservation by federal, state, local, or private organizations. This survey has collected data on development along river corridors and on the characteristics of the rivers such as vegetation, fish, wildlife, and geology, and their cultural, scenic, and recreational value. Initial findings indicate that more than 110,000 miles of rivers, or river segments longer than 25 miles, are potential wild, scenic, or recreational rivers under the Wild and Scenic Rivers Act. An additional 144,000 miles of river in segments between 5 and 25 miles also appear to be potential additions to the system (USDI, 1978).

There is no reliable information on the ownership or accessibility of rivers that are outside of the Wild and Scenic River System. The responsibility for managing and conserving these river resources is divided among various federal, state, local, and private organizations.

The notion that streamflows need to be maintained for recreation is relatively new. But it has gained attention as water is increasingly allocated among competing uses. Consumptive demands for water in watershort areas are generally favored over recreation demands because of legal constraints and economic interests.

Water Rights in the West have traditionally been tied to the beneficial use of water as defined by state laws. Beneficial uses generally include municipal and industrial water supplies, stock watering, agriculture, and mining but seldom recreation or esthetics. Gaining recognition of the necessity for maintaining water in the stream for recreation will be more difficult as consumption of water by agriculture and energy developments heighten the competition for the scarce water resources in many parts of the country.

To be available for public enjoyment, many resources require only some form of protection. Flood plains, coastal beaches, and wetlands in a natural state are examples. They can meet recreation needs, reduce or eliminate flood conditions, and provide a pleasing contrast to intensive urban development.

o Shorelines.--The coastlines of the United States extend more than 84,000 miles (table 6H-8). They range from the rocky shores of New England to the wide sandy beaches of the South Atlantic States and from the estuaries and pristine seacliffs of the Pacific Coast to the flat reefs of the Florida Keys.

The coast provides a popular setting for almost every type of recreational activity, including swimming, boating, fishing, surfing, and skindiving. Picnicking, hiking, camping, nature study, and other land-based activities also take place along the water's edge.

The demand for shoreline-based recreation continues to grow. In particular, many of the country's largest cities and suburbs depend to a great extent on coastal beaches for recreation, and this often leads to extreme overuse of nearby public beaches.

Beaches are very vulnerable resources and can erode to the extent that they become unusable for recreation. Improper construction of jetties, breakwaters, and other structures can aggravate the natural process of erosion by interfering with the water and sand circulation patterns that replenish beaches. Unlimited recreation use inevitably causes environmental damage. Too many people in such fragile areas can destroy the very features that attracted them in the first place.

Urban development along coastal and Great Lakes shorelines has generated major environmental and recreational problems. The dredge and fill needed in real estate development has been particularly damaging to the environment. Since recreation shorelines are highly desirable for other uses, such as industrial and power development, future pressures in many areas will intensify. At the same time, these shorelines will become increasingly valuable in satisfying recreation demand.

As shown in table 6H-8, most coastal land in the continental United States is in private ownership. Recent surveys of coastal land use indicate that substantial amounts of shoreline resources remain undeveloped (table 6H-9). Nevertheless, only a small portion of our coastal areas is open to public recreation and development pressures continue to threaten natural values (USDI, 1978).

Table 6H-8.--United States shoreline ownership, 1971

Owner	U.S. excluding Alaska		Alaska		U.S. including Alaska	
	Miles	Percent	Miles	Percent	Miles	Percent
Federal Goverment--	3,900	11	41,300	88	45,200	54
State and local governments------	4,600	12	5,500	11	10,100	12
Private------------	25,800	70	500	1	26,300	31
Uncertain----------	2,600	7	0	0	2,600	3
Total---------	36,900	100	47,300	100	84,200	100

Source: Corps of Engineers and U.S. Department of the Interior, Heritage Conservation and Recreation Service. The 1978 Nationwide Outdoor Recreation Plan (review draft). (USDI, 1978)

Table 6H-9.--United States shoreline development

Owner	U.S. excluding Alaska		Alaska		U.S. including Alaska	
	Miles	Percent	Miles	Percent	Miles	Percent
Recreation						
Public----------	3,400	9	0	0	3,400	4
Private---------	5,800	16	0	0	5,800	7
Nonrecreational						
Developed-------	5,900	16	300	1	6,200	7
Undeveloped-----	21,800	59	47,000	99	68,800	82
Total-------	36,900	100	47,300	100	84,200	100

Source: Corps of Engineers and U.S. Department of the Interior, Heritage Conservation and Recreation Service. The 1978 Nationwide Outdoor Recreation Plan (review draft). (USDI, 1978)

o Wetlands.--In addition to the many advantages mentioned in other parts of this Appraisal, wetlands provide opportunities for a variety of recreational activities, including fishing, hunting, trapping, nature study, and photography. Hiking, picnicking, camping, and horseback riding are possible during dry periods. Ice skating, snowmobiling, and cross-country skiing opportunities are available in the colder areas.

o Natural Lakes.--The United States has about 250 freshwater lakes with surface areas of 10 square miles or more. Nearly 100 of these lakes are in Alaska, and about 100 are in the 5 states of Minnesota, Wisconsin, Michigan, New York, and Maine. All of the natural lakes with surface areas of 10 square miles or more are located in 23 states (USDI, 1973).

In addition to the natural freshwater lakes, there are a number of significant natural saline lakes. The largest and best known of these are the Great Salt Lake in Utah; Pontchartrain Lake in Louisiana; Salton Sea, Mono Lake, and Eagle Lake in California; Walker Lake in Nevada; and Goose Lake in Oregon and California (USDI, 1973). Altogether, America has more than 100,000 natural lakes ranging from small prairie "pothole" lakes and alpine craters to the expansive Great Lakes. These inland waters, fresh and saline alike, provide opportunities for many different recreational activities, such as swimming, boating, and fishing. They also provide an attractive setting for camping, hiking, and picnicking. Unfortunately, many of these lakes are losing their recreational, natural, and esthetic values as a result of filling, pollution, and peripheral development.

There is a need to identify and protect the lakes that have significant value and that should be managed for outdoor recreation, wildlife conservation, and scenic beauty (USDI, 1973).

o Flood Plains.--Many areas that are adjacent to rivers, streams, and other water courses or bodies and are subject to flooding have excellent recreation qualities. Flood plains are well adapted to the low density recreation uses that require only minimal facility development--for example--hiking, biking, bird watching, camping, and fishing.

In recent years, increasing emphasis has been placed on the use of nonstructural measures to mitigate flood damage. Where floodplain areas have not been heavily developed or where past flood damage offers an opportunity for redevelopment, nonstructural solutions should be considered--especially when programs to acquire parks and open spaces can be coordinated with flood control work. Nonstructural public recreation developments are now authorized under the small watershed program (P.L. 83-566, as amended).

o Farm Ponds.--According to a recent Soil Conservation Service survey, there are 2,497,983 farm ponds in the United States with a surface area of 2,648,059 acres (USDA, 1979). Approximately 70 percent of these ponds have been stocked and are used for recreational fishing or for home use of the fishery resource. Of all the farm ponds in the country, more than half occur in the six states of Texas, Missouri, Mississippi, Oklahoma, Arkansas, and Tennessee. Most of these farm ponds were constructed primarily for water conservation, irrigation, and stock-watering purposes, but they are also used for swimming, boating, picnicking, and fishing in summer and for ice skating

in winter. According to the 1975 National Survey of Hunting, Fishing, and Wildlife-Associated Recreation by the Fish and Wildlife Service, farm ponds account for approximately 11 percent of all warmwater angling in the United States.

This same survey report reveals that in 1975, about 53,929,000 people 9 years old or older participated in more than 1.3 billion days of fishing for an average of 24.5 days per angler. They spent $15.2 billion for fishing activities for an average of $282 per angler, or $11.50 per fishing day. Thirty-seven million (69 percent) of the anglers were men; 16.7 million (31 percent) were women. Sixty-eight percent of the anglers in the United States reside in metropolitan areas and 32 percent in nonmetropolitan areas. In 1975--

> 39.8 million anglers in the United States participated in 831.5 million days of warmwater fishing
>
> 18.4 million anglers participated in 235 million days of coldwater fishing
>
> 16.4 million anglers participated in 207.2 million days of saltwater fishing
>
> 6.7 million anglers participated in 60.9 million days of sea-run fishing
>
> 6.1 million people participated in 61 million days of ice fishing

o Reservoirs.--Although less than half the states have natural lakes with surface areas of 10 square miles or more, more than three-quarters of the states have manmade reservoirs with surface areas of 10 square miles or more (USDI, 1973).

Only within recent years has recreation been included as a specific project purpose for reservoir construction. Many early reservoirs were constructed as single-purpose projects, often by private power companies concerned only with acquiring sufficient land on which to store water for power generation. Little, if any, land was purchased or available for recreation. Reservoirs today play an important role in providing opportunities for outdoor recreation. Many are near urban communities where the need is greatest.

Experience has shown that sediment pools of floodwater-retarding structures and of reservoirs for municipal, industrial, or irrigation water supply frequently provide substantial benefits for recreation or fish and wildlife. Benefits can be substantially increased, however, if recreation is included as a project purpose and appropriate water storage and recreation facilities are provided.

According to the 1977 National Resource Inventories by the Soil Conservation Service, about 2 million surface acres of water in small water bodies, less than 40 acres in size, are used primarily for recreation and for fish and wildlife.

Use of lakes and reservoirs for sport fishing exceeds that of all other categories of water. Sixty-five percent of the warmwater fishing and 48 percent of all coldwater angling in 1975 took place in lakes and reservoirs (USDI, 1977).

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Section I-Organic Residues

Approximately 800 million dry tons of organic residues are produced annually (table 6I-1). They are a valuable national resource and their proper and efficient use is important. These residues have often been considered wastes and they have, in fact, caused widespread pollution of water, air, and soils as various attempts to dispose of them properly have failed.

Most organic residues originate in the soil and their production depletes the soil to some degree. But most can be returned to the soil to improve it. The reuse of these residues will gain favor in the future as we seek to minimize pollution of air, soil, and water; reduce our use of energy; and maintain the productivity of our soils.

In 1978, the U.S. Department of Agriculture prepared a report entitled "Improving Soils with Organic Wastes" in response to Sec. 1461 of PL 95-113 (Food and Agriculture Act of 1977). The following is a summary. For each major kind of organic residue, the report gives details on the quantities produced, quality, value, current uses, constraints on use, and opportunities for more effective use. Data are provided for seven types of organic residues:

- Animal and poultry manure
- Crop residues
- Sewage sludge and septage
- Food processing residues
- Industrial organic residues
- Logging and wood manufacturing residues
- Municipal refuse

Quantity and Use

Table 6I-1 shows the total amount of each kind of organic residue generated annually. About 54 percent of the total organic residues are crop residues. Manure and crop residues combined make up about 76 percent of the total organic residue generated each year. About three-fourths of the animal manure and crop residues are now used to improve the fertility and tilth of the soil. Sewage sludges make up 0.5 percent of the total residues. About one-fourth of these are currently used on the land.

Other organic residues have not been used extensively on the land because of competitive uses; costs of collection, processing, transportation, and application; or possible chemical and physical problems. Certain residues have limited availability, acceptability, or utility for soil application.

How Adding Organic Residues Affects Soil Productivity

The physical properties of the soil influence the amount, distribution, and movement of water and air in the soil; the growth of roots; the degree of soil crusting; the soil's water-holding capacity; the soil temperature; and the efficacy of soil tillage. Adding organic residues to the soil not only improves these properties, but also helps to control wind and water erosion and to conserve water and soil nutrients.

Table 6I-1.--Quantity, use, and potentials of organic residues

Organic waste	Annual production (1,000 dry tons)	Percentage of total	Percentage used on land 1/	Feasibility for increased use 2/	Potential for more efficient use of fertility value 2/
Animal manure-----	175,000	21.8	90	low	high
Crop residues-----	431,087	53.7	68	low	low
Sewage sludge and septage---------	4,369	0.5	23	medium	very high
Food processing---	3,200	0.4	(13)	low	low
Industrial organic---------	8,216	1.0	3	low	low
Logging and wood manufacturing--	35,714	4.5	(5)	very low	very low
Municipal refuse-	145,000	18.1	(1)	low	very low
Total--------	802,586	100.0			

1/ Values in parentheses are estimates.
2/ Very high indicates a likely increase of greater than 100 percent, high indicates a 50 to 100 percent increase, medium indicates a 20 to 50 percent increase, low indicates a 5 to 20 percent increase, and very low indicates less than a 5 percent increase.

Adding organic residues to soils changes their physical and chemical characteristics and improves their tilth and fertility. The chemical properties that may be improved include the soil's capacity to bind positively charged ions of hydrogen, calcium, magnesium, and other elements. Organic residues also add to the quantity of major plant-nutritional elements, nitrogen (N), phosphorus (P), and potassium (K), in the soil and provide small but significant amounts of trace elements essential for plant growth.

Less desirable constituents of some organic residues include metals injurious to crops, animals, or both. These metals can also harm humans who eat affected plants or animals. Some organic residues contain other kinds of toxic compounds.

The Value of Organic Amendments as a Replacement for Fertilizer

Part of the value of an organic amendment can be calculated in terms of the cost of an equivalent amount of nitrogen (N), phosphorus (P), and potassium (K) in inorganic fertilizer. Unit costs of these elements vary according to the form of the inorganic fertilizer, the changing costs of fertilizer production, and other more general economic conditions. The calculations in this report are based on the average prices paid by farmers for N, P, and K in commercial fertilizers as of March 15, 1978. Those costs are listed in table 6I-2.

Table 6I-2.--Estimates of average prices paid by farmers in the United States for fertilizer nutrients in commercial fertilizers as of March 15, 1978

Nutrients	Dollars per ton	Dollars per pound
Nitrogen as N------------------	300	0.15
Phosphorus as P----------------	800	.40
Potassium as K-----------------	200	.10

The quantities of nitrogen, phosphorus, and potassium returned to the land are substantial (table 6I-3). Based on 1977 data, current estimates are that organic wastes are returned to the land in amounts that are equal to 86 percent of the nitrogen, 90 percent of the phosphorus, and 152 percent of the potassium purchased as commercial fertilizer.

Increased use of organic wastes on land could reduce the need for commercial fertilizers as a source of nitrogen only to a limited extent. These are about 4.5 million tons of nitrogen in organic wastes that are not currently applied to the land. This amount is far short of the annual demand for 10.6 million tons of commercial nitrogen. Furthermore, much nitrogen in organic wastes is not readily available because of the high carbon to nitrogen ratio or the losses of ammonia in handling and application. The greatest opportunity for using more organic wastes for nitrogen is through greater use and more efficient handling of animal manures.

The amounts of phosphorus and potassium in organic wastes that are not being used on the land equal 69 percent and 57 percent, respectively, of the current purchases of these two nutrients in commercial fertilizer. It would not be feasible to apply all of this phophorus and potassium because a large part is contained in municipal refuse. Municipal refuse also contains metal, plastic, glass, and paper and, therefore, it cannot be applied to the land wouthout considerable sorting and handling.

The Economic Values of Improved Tilth and Physical Soil Conditions

It is difficult to assign dollar values to the beneficial effects of improved tilth and physical soil properties that result from added organic matter. Crops respond to a complex interaction of physical, chemical, and microbiological processes that are not readily separated on a quantitative basis. Organic residues are of much more value when applied to some soils than to others, largely because of differences in the amount of organic matter already in the soil and in the relative benefit of the added organic residues. Soils low in organic matter usually respond best. Applying residues on eroded soils or soils in drastically disturbed areas, such as those created by surface mining, effectively increases their productivity and decreases erosion. On the other hand, applying organic residue on

soils already high in organic matter may produce little benefit except for the fertilizer value.

High quality residues such as composted and dewatered sludge are valuable for specialized applications. They are effective as soil substitutes in urban landscaping ($14.85/ton soil replacement value) or as potting media in the greenhouse-nursery trade and home gardens ($40.00 to $60.00/ton replacement value). Composting high quality wastes for these uses costs from $5.00 to $20.00 per ton.

Most organic residues discussed in this report have lower values for improving soil tilth. However, this value is still appreciable on most soils and may range between $1.00 to $5.00 per dry ton for most wastes.

In this report it is assumed that organic residues are applied to soils according to sound, locally approved soil and water conservation practices. Such practices minimize the extent to which components of the residue enter surface and ground waters. They also reduce odors and provide for application to those soils which will benefit most.

Costs of Collection, Processing, Transportation, and Application

The costs of handling organic residues vary from one kind of residue to another and from one location to another. Therefore, aggregate estimates of these costs have not been assembled because they would be of little value. Specific costs, however, are of obvious importance in analyzing the net advantages of applying organic residue to soils in any particular situation. When such analyses are made, the cost of alternative methods of disposal and/or the costs or benefits of alternate uses must be evaluated. The analyses should consider benefits resulting from the prevention or reduction of water pollution.

The value of manure on soils generally exceeds the costs of handling it by a ratio of about 2:1. The cost of handling crop residues is generally zero; residues are merely left on the land and plowed under. Land disposal of sewage sludges, food processing residues, and industrial organic residues is costly, but in many situations it is the least costly option when benefits to soils are considered in the evaluation. For most industrial organic residues, wood manufacturing residues, and municipal refuse, the costs of handling or values in competitive uses exceed their benefits for soils.

Potential for Increased Usage

The following is a list of ways to increase the effective use of organic residues on soils:

1. Improving the handling of manures to decrease loss of nitrogen.
2. Applying manures that are now wasted.

Table 6I-3.--Total content of nitrogen (N), phosphorus (P), and potassium (K) in organic residues and amounts of these nutrients that are currently used on land

Organic waste	Total content N	Total content P	Total content K	Current use on land N		Current use on land P		Current use on land K	
				1,000 tons/year 1/					
Animal manure------	7,700	1,900	4,200	5,578	(52)	1,710	(70)	3,780	(78)
Crop residue-------	4,801	665	5,270	3,423	(32)	443	(18)	3,504	(72)
Sludge and septage-	187	91	18	44	(1)	25	(1)	5	(1)
Food processing----	32	6	50	5	(1) 2/	1	(1)2/	7	(1) 2/
Industrial organic 4/-------	---	---	---	---	---	---	---	---	---
Logging and wood manufacturing 4/-	---	---	---	---	---	---	---	---	---
Municipal refuse---	812	1,218	502						
Total---------	13,532	3,880	10,040	9,050	(86)	2,179	(90)	7,296	(152)
Commercial fertilizer 3/----				10,642		2,453		4,855	

1/ Quantity of nutrients in the organic residue is expressed, in parenthesis, as a percentage of the total quantity of the nutrient purchased as commercial fertilizer in 1977.

2/ Data are estimates of maximum values. Insufficient data are available to provide a more complete evaluation.

3/ Commercial fertilizer use for year ending June 30, 1977.

4/ Data not available.

3. Applying crop residues that are not being fully utilized.
4. Increasing the percentage of sewage sludge currently applied.
5. Increasing the use of the organic part of municipal refuse.

Aggregating the values shown in tables 6I-2 and 6I-3 for each type of residue, indicates that the maximum added value that could result from these actions is $0.84 billion annually. Municipal refuse probably has more value for energy generation, however, than for soil improvement. If municipal refuse is omitted from the aggregate, an annual added value of $0.58 billion is possible, principally through the improved handling of manures.

It is possible to increase the use of each category of residue on soils if future research shows that existing constraints can be removed and if the value of the residue for improving soil tilth and fertility can be shown to be greater than its value for competitive uses.

Certain competitive uses for organic residues must be considered even though these uses could decrease their availability for use on soils. The most discussed, and perhaps most likely, competitive use of organic residues is in energy production. Of greatest concern are biomass systems that would remove the entire above-ground portion of crops for use in producing energy. Biomass production of ethanol and methanol for making gasohol is not economically feasible at the present time without a substantial subsidy. Production of methane gas from animal wastes shows more promise--at least for providing a portion of on-farm energy needs. Caution is urged in developing these systems until their potentially adverse impact on soil fertility, tilth, and erosion is more adequately investigated. Additional research and pilot project demonstrations are needed to further define the economic feasibility of methane production. With additional research and demonstrations, it is likely that substantial amounts of crop and other organic residues could be safely used for the production of gasohol.

Research Needs

A national survey is needed to establish a data base on the amounts and quantities of organic wastes being generated. We also need a better understanding of the effects of waste processing on the value of organic residues for application on land. More research is necessary on the differing abilities of organic residues to improve soil tilth and fertility and the impact on soil erosion and productivity of removing crop residues for use in energy generation. A 1978 report, "Improving Soils with Organic Wastes," discussed these and other research needs, as well as recommendations for educational programs.

Conclusions

Applying organic residues to land benefits several segments of our society. Farmers can save on the purchase of commercial fertilizer. The nonfarm population also benefits from land application of organic residues. Where land application of sludge or composting is the most cost-effective alternative for managing residue, public costs of disposal can be reduced.

Often the amounts and types of organic residues already being applied to the land are the most practicable, desirable, and feasible. Only the use of municipal sewage sludges and septage on land is expected to increase appreciably, but the total amount will be very small compared to the largest categories of residues, i.e., animal manures and crop residues. There is potential, however, for more efficient use of the fertility value of animal manure, municipal sludge, and septage. Competitive uses for food processing and logging and wood manufacturing residues, numerous potential toxins in organic industrial residues, and the undesirable chemical and physical properties of municipal refuse restrict greater use of these residues.

The present and projected use of organic residues per se as a source of plant nutrients will probably have only a modest impact on reducing the use of commercial fertilizers. In U.S. agriculture it is not feasible to adapt organic residues as a complete alternative to commercial fertilizer in order to achieve the most effective crop production. Not only is the supply of residues insufficient, but the composition normally will not provide a proper proportion of the needed plant food elements.

Reference

U.S. Department of Agriculture, Soil Conservation Service. 1978. Improving soils with organic wastes.

Section J-Livestock and Poultry

Livestock and poultry use a wide range of resources that otherwise would contribute little to feeding mankind. These resources include grasslands, plant and animal byproducts, cellulosic wastes, crop residues, roots, nuts, garbage, and wastes from vegetables, fruits, and animals. On most cropland, almost half of the total digestible energy in the crops is left after harvesting. Using this residue to feed livestock and poultry reduces soil, water, or air pollutants.

Beef cattle and sheep that are grain-fed prior to marketing, including those finished out in feedlots, get by far the greatest percentage of their total feed from grass and roughage that otherwise would be wasted. USDA records for 1973 (Kottman, 1976) suggest that 53.9 percent of the nutrients fed to our Nation's beef cattle are from pasture and range; 23.7 percent from harvested forage; 1.5 percent from high protein supplements; 1.1 percent from byproducts; and only 19.8 percent from grain. When the number of cattle peaked at 132 million head in 1975, less than 8 percent of the total inventory was on grain rations in feedlots.

Livestock on rangelands provide very energy efficient meat production. Studies at Colorado State University (Cook, 1976, and Cook et al.,1976) found that 1 kilocalorie of edible beef could be produced on rangeland from 5 kilocalories of cultural energy. Feedlot meat production, using farm-raised feeds, required 15 kilocalories of cultural energy to produce 1 kilocalorie of edible beef. A semiconfinement system using rangeland and drylot feeding produced 1 kilocalorie of edible beef from an input of 9 kilocalories of cultural energy. Studies by Steinhart and Steinhart (1975), Workman (1975), and Martin (1975) also indicate that meat production in the feedlot requires 2½ to 10 times more energy than it does on rangelands.

Livestock constitute a storehouse of food that reduces our vulnerability to periods of poor crop production. Only 3 percent of the animal protein consumed by man comes from fish and aquaculture. Nearly 70 percent of the animal protein used by man comes from ruminant animals. It is estimated that in 1974, the animals in the world, not ordinarily slaughtered during the year, constituted a 40-day reserve food supply. This food reserve was larger than the 27-day reserve supply in grain stocks. Animals not only provide a 50 percent larger reserve than grain, but they are also available throughout the world. Grain stocks, on the other hand, are limited to certain locations which reduces their availability (Cunha, 1978).

The United States has a tremendous capacity to further increase its output of animal products to meet our needs in the year 2000. For example, beef production could increase a great deal with the proper application of technology and favorable market conditions.

Only about 40 pounds of beef are now produced per acre on the 11.5 million acres of forage land used for beef in Florida. However, a cow-calf program at the University of Florida's Beef Research Unit is producing 400 pounds of beef per acre. Therefore, if all its acreage were improved pasture and managed properly, Florida could increase its beef production 10 times.

Similar examples could be given for other southeastern states. In the Midwest, cow-calf production could be increased considerably by using silage from corn cobs and stalks as feed. This silage is now largely going to waste. Therefore, the United States has not reached the limit of its beef production.

Status

The data on livestock status and trends in table 6J-1 are mostly from reports by USDA's Economics, Statistics, and Cooperatives Service. Data on horses are from the American Horse Council (1976), and data on reindeer are from SCS personnel in Alaska.

As of January 1, 1976, there were 110.9 million cattle and calves. Of these, 37 million were beef cows that calved and 10.9 million were dairy cows (table 6J-1). There were 12.2 million head of sheep, 8.3 million of which were ewes over 1 year old. Another 2.2 million were stocker ewes and ram lambs.

Texas is the only state that reports data on goats. These are Spanish goats raised for meat and angora goats raised for mohair production. Both types are also used in brush management. Texas has 1.4 million goats, nearly all of which graze on rangeland.

In 1976 there were 8,064,000 horses. Estimates of the 1978 population indicate very little change; the reason given is that slaughter is nearly equal to reproduction. The price of horses for slaughter escalates in accordance with beef prices. Currently, the worldwide demand seems to be increasing (Shinitzky, 1979).

All of the 25 to 30 thousand domestic reindeer are in Alaska. There is increasing commercial interest in reindeer as a meat source. Their antlers are also sold to East Asian countries where they are ground into a powder that is used as an aphrodisiac.

Condition

The livestock industries are all technically capable of increasing production. They are able to control most diseases and parasites. They have improved their efficiency and the rate of animal gains and they are also making advances in increasing reproduction rates. Livestock wastes are now being handled more safely. As a result of research on energy and nutrition, animal wastes are becoming a resource instead of a problem.

It appears that the major constraint on increasing livestock production is the availability of forage at a reasonable price. Table 6J-2 shows acreages of nonfederal lands used for forage production. The country's forage land is presently stocked at near capacity. Table 6J-3 shows current stocking rates by states. Rates range from 0.7 to 34 acres of nonfederal forage land (perennial types) per animal unit. Twenty-nine states show less than 5 acres per animal unit. The RCA and RPA data indicate that 60 percent of the nonfederal rangeland and 54 percent of the federal rangeland are in less than satisfactory range condition.

Table 6J-1.--Livestock populations in the United States (all units 1,000's)

States	Beef cows that calved in 1978	Dairy cows	Total 2/ cattle and calves	Ewes 1 year and older	Stocker ewe and ram lambs	Total 2/ sheep and lambs	Goats	1976 AHC estimates (1000's) Horses	Reindeer	Total animal unit (1000) 1/
Ala.	901	84	1,820	2.5	1	3.7	---	169	---	1,635
Alaska	2	1	8	2.9	.9	5.5	---	9	25-30	6,019
Ariz.	287	70	1,200	288	81	465	---	143	---	1,063
Ark.	1,040	90	2,000	3.4	1.2	4.9	---	168	---	1,798
Calif.	930	860	4,700	838	101	1,150	---	832	---	4,725
Colo.	843	72	3,090	393	70	795	---	162	---	2,378
Conn.	9	49	101	3.8	1	5.1	---	41	---	148
Del.	3	12	30	1.2	.4	1.7	---	11	---	40
Fla.	1,149	189	2,180	2.7	1	4	---	170	---	2,019
Ga.	731	129	1,650	2.3	.6	3.2	---	159	---	1,487
Hawaii	78	13	215	---	---	---	---	13	---	172
Idaho	584	141	1,900	369	79	466	---	166	---	1,644
Ill.	747	236	2,850	127	33	184	---	305	---	2,392
Ind.	482	202	1,750	124	29	171	---	124	---	1,455
Iowa	1,684	374	7,300	220	85	380	---	158	---	5,043
Kan.	1,754	136	6,200	125	20	208	---	198	---	4,368
Ky.	1,070	265	2,600	18	3	22	---	205	---	2,294
La.	703	127	1,350	9	3	13	---	187	---	1,359
Maine	9	56	124	8	3	12	---	34	---	154
Md.	59	134	374	14	4	19	---	66	---	404
Mass.	9	46	95	4.9	1.3	6.7	---	32	---	128
Mich.	138	402	1,250	75	17	121	---	214	---	1,288
Minn.	530	850	3,650	160	46	255	---	201	---	3,027
Miss.	950	103	1,790	3.1	1.1	4.5	---	185	---	1,679
Mo.	2,284	276	5,550	83	25	126	---	223	---	4,427
Mont.	1,453	27	2,607	324	120	475	---	279	---	2,489
Nebr.	1,977	123	6,450	76	21	175	---	97	---	4,461
Nev.	280	15	560	89	16	114	---	70	---	541
N.H.	4	30	68	4.8	1.7	6.9	---	28	---	95
N.J.	15	43	108	6.9	2.1	9.6	---	36	---	141
N. Mex.	602	33	1,500	432	100	604	---	122	---	1,343
N.Y.	75	904	1,711	42	19	63	---	280	---	1,933
N.C.	402	143	1,080	5	1.4	7	---	147	---	1,034
N. Dak.	961	97	1,967	115	40	198	---	48	---	1,634
Ohio	388	382	1,850	236	46	350	---	232	---	1,764
Okla.	2,138	112	5,300	57	15	89	---	285	---	4,176
Oreg.	597	93	1,475	260	79	460	---	156	---	1,388
Pa.	171	703	1,840	55	15	75	---	127	---	1,706
R.I.	1	5	9	1.6	.3	2	---	11	---	22
S.C.	254	51	575	0.9	.3	1.3	---	94	---	572
S.Dak.	1,391	169	3,750	534	145	740	---	113	---	2,979
Tenn.	1,050	210	2,350	9	3	13	---	222	---	2,138
Tex.	5,890	310	13,900	1,667	663	2,415	1,360	816	---	11,801
Utah.	312	77	810	388	64	486	---	137	---	880
Vt.	10	189	320	5.6	1.2	8	---	17	---	329
Va.	588	172	1,550	125	30	160	---	146	---	1,410
Wash.	380	190	1,375	39	14	56	---	170	---	1,242
W. Va.	233	37	535	88	22	115	---	51	---	497
Wis.	228	1,810	4,100	63	19	95	---	142	---	3,717
Wyo.	613	11	1,300	759	196	1,105	---	63	---	1,255
U.S.	36,989	10,853	110,867	8,260.6	2,241.5	12,249.1	1,360	8,064	25-30	100,693

1/ Used animal units defined in National Range Handbook, 1976 except for dairy cows (=1.25 AU.) and reindeer (=.2 AU.)

2/ Includes replacement, stocker, and other cattle or sheep not included in the two previous columns.

Table 6J-2.--Nonfederal forage lands (all units 1,000's)

	Range-Land	Native Pasture	Pasture-Land	Grazed Forest Land	Hayland	Nonfederal Forage Land Total
Ala.	0	7	4,113	1,621	259	6,000
Alaska	6,276			0		6,276
Ariz.	35,092	0	11	1,382	129	36,614
Ark.	249	1,049	4,576	2,326	433	8,633
Calif.	17,555	183	950	3,775	1,196	23,659
Colo.	23,802	505	1,096	2,676	1,877	29,956
Conn.	0	3	110	18	93	224
Del.	0	0	22	1	6	29
Fla.	3,018	1,006	4,474	2,973	59	11,530
Ga.	0	0	3,232	12	282	3,526
Hawaii	0	9	981	156	0	1,146
Idaho	6,586	0	1,114	1,843	1,579	11,122
Ill.	0	0	3,068	600	1,483	5,151
Ind.	0	0	2,148	409	1,062	3,619
Iowa	0	258	4,269	766	2,936	8,229
Kans.	16,272	334	2,369	325	1,847	21,147
Ky.	0	0	5,734	1,424	1,775	8,933
La.	325	914	2,032	3,215	243	6,729
Maine	0	96	153	26	532	807
Md.	0	4	476	78	260	818
Mass.	0	18	74	37	162	291
Mich.	0	525	701	333	2,121	3,680
Minn.	112	757	2,130	1,368	3,844	8,211
Miss.	30	519	3,521	2,332	274	6,676
Mo.	35	617	12,206	3,816	2,836	19,510
Mont.	38,833	371	2,280	3,087	2,291	46,862
Nebr.	22,001	587	2,308	229	3,474	28,599
Nev.	7,349	3	296	169	990	8,807
N.H.	0	35	58	32	218	343
N.J.	0	10	135	13	127	285
N. Mex.	42,096	249	136	2,490	322	45,293
N.Y.	0	912	1,370	608	3,052	5,942
N.C.	0	163	1,862	735	290	3,050
N. Dak.	10,564	99	1,460	150	3,027	15,290
Ohio	0	36	2,578	741	1,915	5,270
Okla.	14,569	1,873	6,843	3,332	744	27,361
Oreg.	10,109	564	1,202	2,309	1,468	15,652
Pa.	0	253	1,544	382	2,625	4,804
R.I.	0	0	15	5	15	35
S.C.	0	69	1,173	485	110	1,837
S. Dak.	22,199	0	2,412	279	4,467	29,357
Tenn.	0	0	5,473	1,596	985	8,054
Tex.	95,401	3,489	15,284	4,883	1,507	120,564
Utah	9,362	17	610	900	942	11,831
Vt.	0	277	263	116	485	1,141
Va.	0	292	2,984	1,100	748	5,124
Wash.	6,041	210	1,041	2,637	818	10,747
W. Va.	0	395	1,644	792	704	3,535
Wis.	4	483	2,259	1,554	5,353	9,653
Wyo.	26,171	1	732	896	1,424	29,224
Caribbean	65	515	347	23	0	950
U.S. & Caribbean	414,116	17,707	115,859	61,055	53,389	672,126

Table 6J-3.--Acres of forage land per animal unit

	Total animal units 1/ (1000)	Total nonfederal forage land (1000)	Acres of nonfederal forage land per AU
Alabama-------------	1,635	6,000	3.7
Alaska--------------	6,019	6,276	1.0
Arizona-------------	1,063	36,614	34.4
Arkansas------------	1,798	8,633	4.8
California----------	4,725	23,659	5.0
Colorado------------	2,378	29,956	12.6
Connecticut---------	148	224	1.5
Delaware------------	40	29	0.7
Florida-------------	2,019	11,530	5.7
Georgia-------------	1,487	3,526	2.4
Hawaii--------------	172	1,146	6.7
Idaho---------------	1,644	11,122	6.8
Illinois------------	2,392	5,151	2.2
Indiana-------------	1,455	3,619	2.5
Iowa----------------	5,043	8,229	1.6
Kansas--------------	4,368	21,147	4.8
Kentucky------------	2,294	8,933	3.9
Louisiana-----------	1,359	6,729	5.0
Maine---------------	154	807	5.2
Maryland------------	404	818	2.0
Massachusetts-------	128	291	2.3
Michigan------------	1,288	3,680	2.9
Minnesota-----------	3,027	8,211	2.7
Mississippi---------	1,679	6,676	4.0
Missouri------------	4,427	19,510	4.4
Montana-------------	2,489	46,862	18.8
Nebraska------------	4,461	28,599	6.4
Nevada--------------	541	8,807	16.3
New Hampshire-------	95	343	3.6
New Jersey----------	141	285	2.0
New Mexico----------	1,343	45,293	33.7
New York------------	1,933	5,942	3.1
North Carolina------	1,034	3,050	2.9
North Dakota--------	1,634	15,290	9.4
Ohio----------------	1,764	5,270	3.0
Oklahoma------------	4,176	27,361	6.6
Oregon--------------	1,388	15,652	11.3
Pennsylvania--------	1,706	4,804	2.8
Rhode Island--------	22	35	1.6
South Carolina------	572	1,837	3.2
South Dakota--------	2,979	29,357	9.9
Tennessee-----------	2,138	8,054	3.8
Texas---------------	11,801	120,564	10.2
Utah----------------	880	11,831	13.4

Table 6J-3.--Acres of forage land per animal unit--Continued

	Total animal units 1/ (1000)	Total nonfederal forage land (1000)	Acres of nonfederal forage land per AU
Vermont----------	329	1,141	3.5
Virginia---------	1,410	5,124	3.6
Washington-------	1,242	10,747	8.7
West Virginia----	497	3,535	7.1
Wisconsin--------	3,717	9,653	2.6
Wyoming----------	1,255	29,224	23.3
Caribbean--------		950	
Total--------	100,693	672,126	6.7

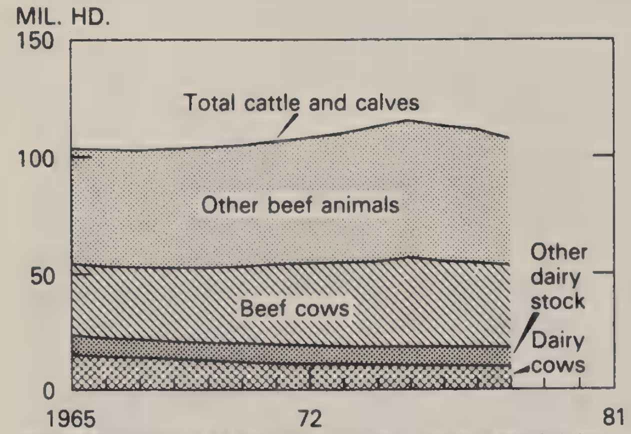
1/ Used animal units defined in National Range Handbook, 1976 except for dairy cows (=1.25 AU.) and reindeer (=.2 AU.)

Increased meat production through genetic improvement in animals is slow, whereas forage production can be increased in a relatively short period through the transfer and application of existing technology.

Trend

Meat Production and Consumption.--The supply of all meat in 1979 is expected to be slightly larger than in 1978 and could approach record levels. The consumption of beef, however, should continue to decrease in the next 12 to 24 months. With an average of 120 pounds (calculated on carcass weight) per person, beef consumption in 1978 was 5 percent less than in 1977. USDA anticipates a further drop to around 112 pounds per person in 1979. Pork consumption in 1978 was 62 pounds per person, about the same as in 1977. An increase of more than 10 percent to about 68 pounds is expected this year. Poultry consumption was almost 58 pounds per person in 1978, up about 6 percent from a year earlier. USDA expects a further increase of about 8 percent to 62 pounds in 1979. As a result, lower beef availability would be offset by increases in pork and poultry consumption.

Inventory and Trends.--Good pasture conditions and higher cattle prices can help rebuild cow inventories over the next 3 to 5 years. The rate of increase in the cow herd is extremely important because it is the primary determinant of future beef supplies (USDA, 1978a). The trends in the production and consumption of livestock, poultry, and related products are shown in figures 6J-1 through 6J-5.

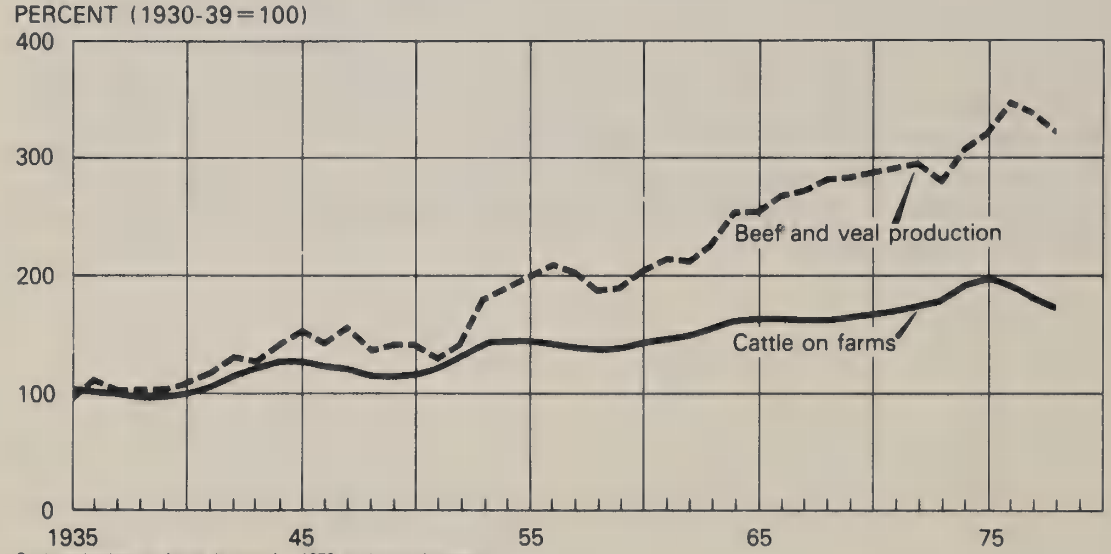


Beef cows and dairy cows are those that have calved. Other dairy stock includes estimate of replacement heifer calves.

Cattle on Farms, January 1

	1975	1976	1977	1978[1]
	Million head			
Cattle and calves[2]	132.0	128.0	122.8	116.3
Beef cows	45.7	43.9	41.4	38.8
Other beef animals	66.9	65.1	62.6	58.8
Dairy cows	11.2	11.1	11.0	10.9
Other dairy stock[3]	8.2	7.9	7.8	7.8

[1] Preliminary. [2] The 1979 forecast is 111-112 million head. [3] Includes estimate of replacement heifer calves.



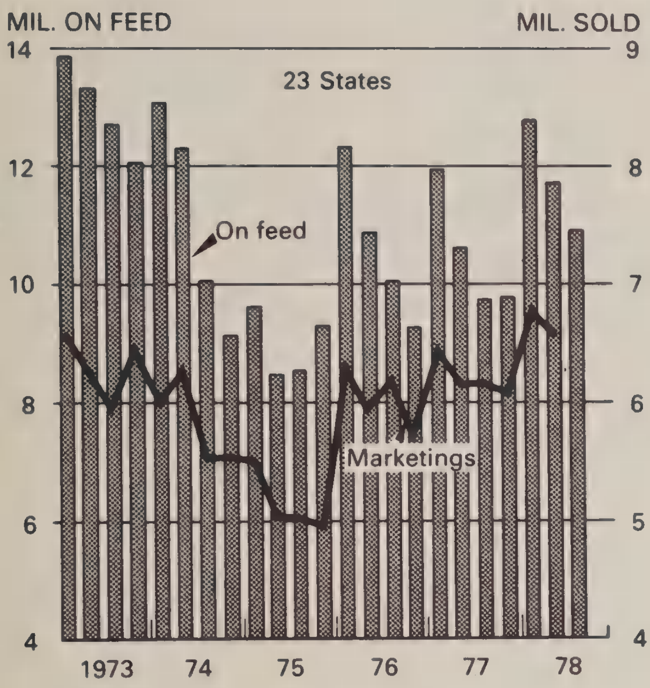
Cattle and calves on farms, January 1. 1978 production forecast.

Cattle Numbers, Beef and Veal Production, and U.S. Population[1]

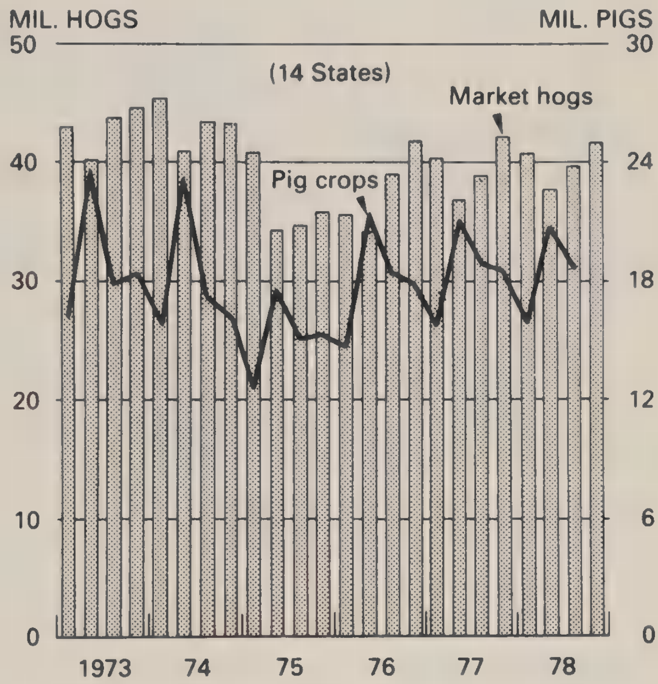
	1940	1950	1960	1970	1974	1975	1976	1977	1978[2]
					1930-39=100				
Cattle and calves on farms, January 1	102	117	144	168	191	197	191	184	174
Beef and veal production	106	140	206	289	307	323	349	339	322
Population[3]	104	118	140	159	165	167	168	169	171

[1] Averages for 1930-39 are: Cattle and calves on farms, January 1, 66.9 million head; beef and veal production, 7,695 million pounds; and U.S. population, 126.9 million. [2] Forecast. [3] Civilian population, July 1.

Figure 6J-1.--Cattle on farms, January 1 (top); change in cattle numbers and beef production (bottom).



Figures are million head, quarterly data.

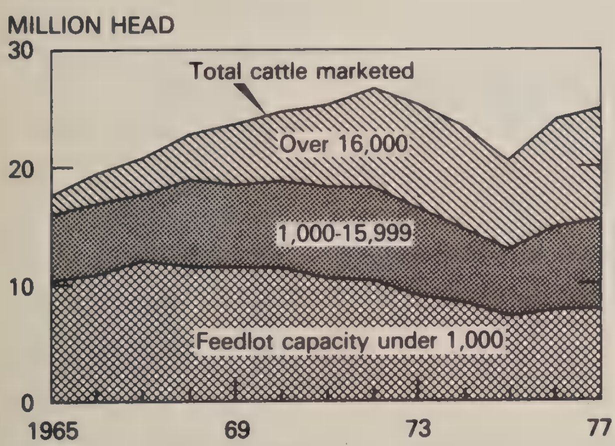


Pig crops — Dec.-Feb., Mar.-May, June-Aug., Sept.-Nov. Market hogs on farms — Dec. 1 previous year, March 1, June 1, Sept. 1. Dec. 1.

Pig Crops, Hog Slaughter, and Pork Production

	1975	1976	1977	1978[1]
	Million head			
Pig crops	71.2	84.4	86.2	87.3
Spring	35.5	42.2	43.0	42.3
Fall	35.7	42.2	43.2	45.0
Hog slaughter	69.9	75.0	78.4	78.7
	Million pounds			
Pork production	11,779	12,688	13,247	13,385

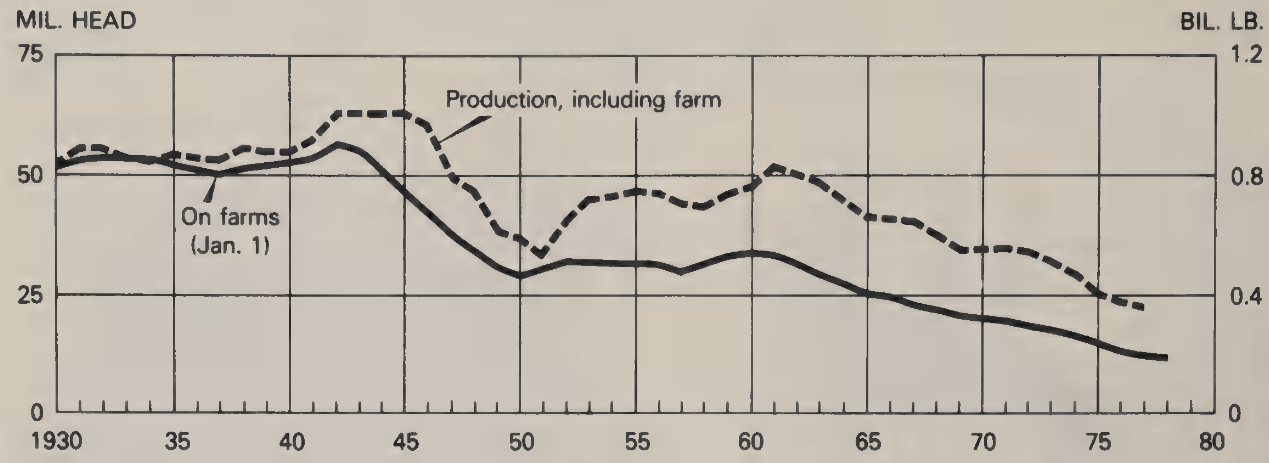
[1] Spring pig crop preliminary; all other data for 78 is forecast.



Data are for 23 States.

Source: Cattle on Feed report, Economics, Statistics, and Cooperatives Service, USDA.

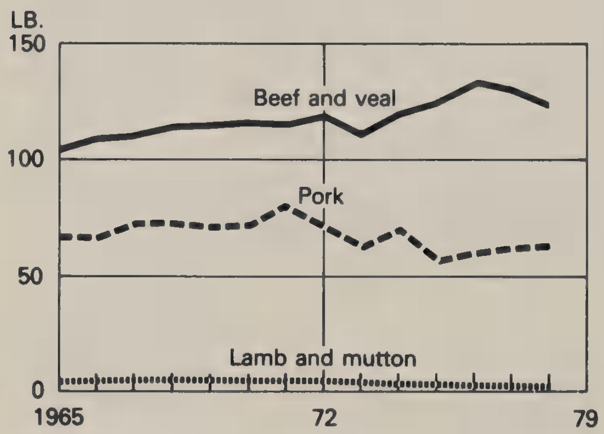
Figure 6J-2.--Cattle on feed and marketings (top left); market hogs and pig crops (right); fed cattle marketed by feedlot capacity (lower left).



1978 production forecast.

Sheep Numbers and Lamb and Mutton Production

	1930	1940	1950	1960	1970	1975	1976	1977	1978
					Million head				
Sheep and lambs on farms	51.6	52.1	29.8	33.2	20.4	14.5	13.3	12.8	12.4
					Million pounds				
Lamb and mutton production	825	876	597	768	551	410	371	351	310



Pounds in carcass-weight basis. 1978 forecast.

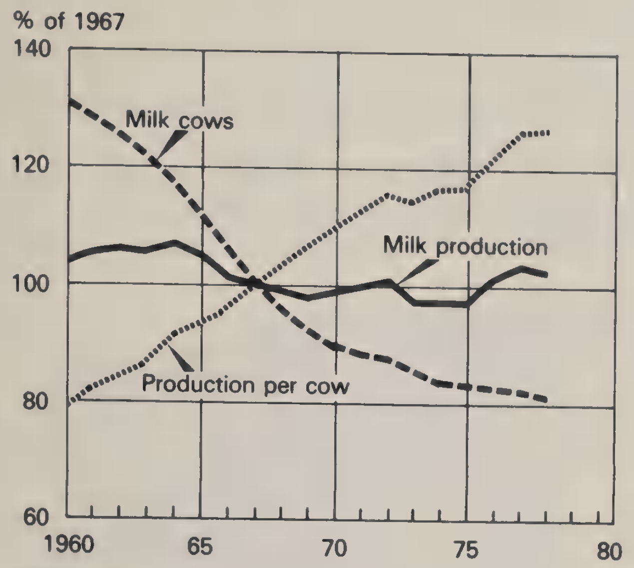
Meat Consumption Per Person

	1975	1976	1977	1978[1]
		Pounds		
Total per capita meat consumption	182.4	194.7	193.0	187.0
Beef	120.1	129.3	125.9	120.3
Veal	4.2	4.0	3.9	3.0
Lamb and mutton	2.0	1.9	1.7	1.6
Pork	56.1	59.5	61.5	62.1

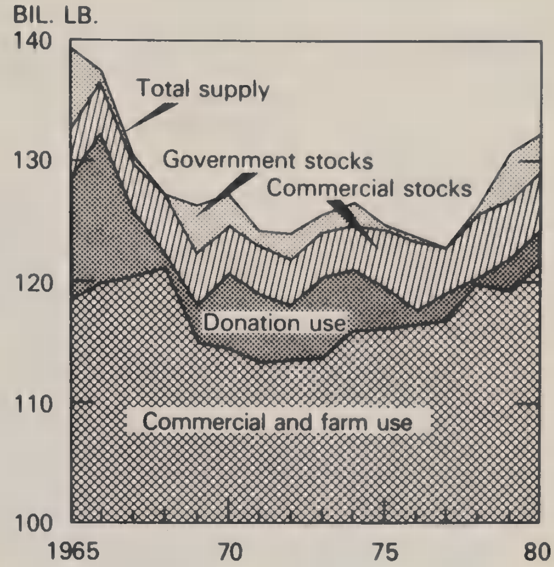
[1] Forecast.

Data published currently in *Livestock and Meat Situation* (ESCS).

Figure 6J-3.--Sheep numbers and lamb and mutton production (top); meat consumption per person (bottom).



1978 forecast.



Stocks as of December 31. 1978 forecast.

Milk Production, Number of Cows, and Milk Per Cow

	1975	1976	1977	1978[1]
Milk production:				
Billion pounds	115.3	120.3	123.0	121.7
Percentage of 1967	97.1	101.3	103.6	102.5
Milk cows on farms:[2]				
Million	11.1	11.1	11.0	10.8
Percentage of 1967	82.8	82.8	82.1	80.6
Milk production per cow:				
Pounds	10,350	10,879	11,194	11,230
Percentage of 1967	116.9	122.9	126.5	126.9

[1] Forecast. [2] Average number on farms during the year, excluding heifers not yet fresh.

Computed from data published in *Milk Production, Disposition, and Income* (ESCS).

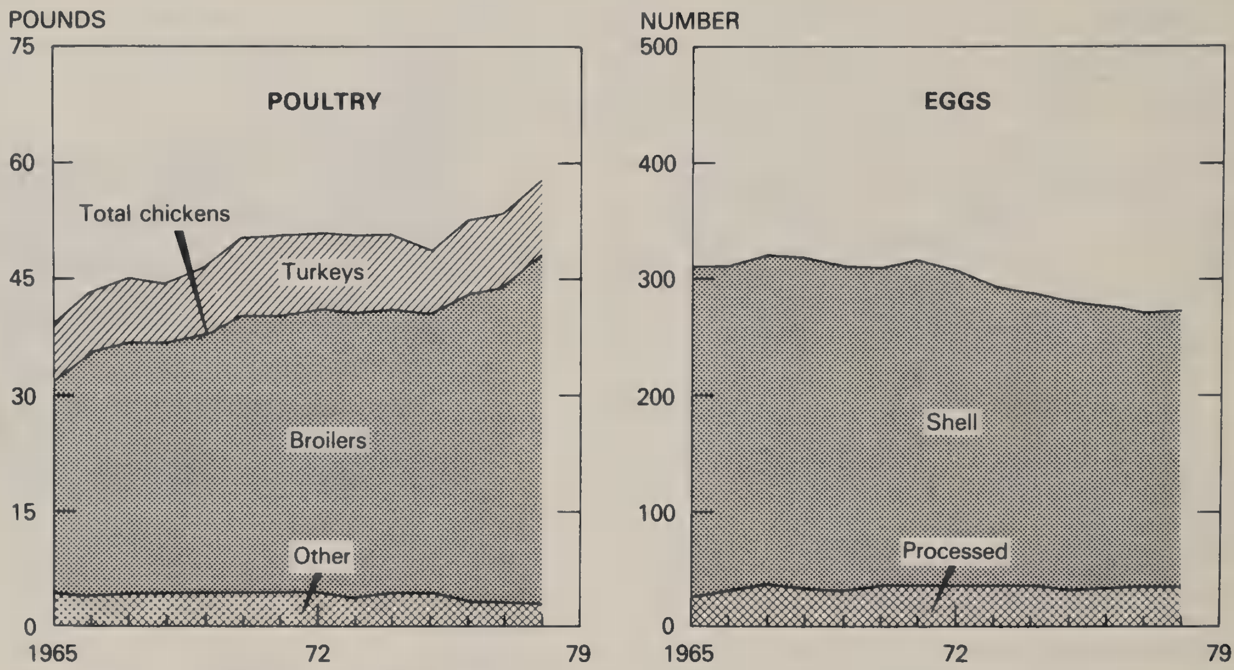
Milk Supply, Use, and Stocks

	1975	1976	1977	1978[1]
	Billion pounds			
Supply[2]	122.7	126.1	130.6	132.3
Production	115.3	120.3	123.0	121.7
Imports	1.7	1.9	2.0	2.0
Use	119.0	120.4	122.3	124.3
Commercial and farm	116.8	119.9	119.3	121.6
Domestic donations[3]	2.3	.5	3.0	2.7
Government exports[4]	([5])	([5])	([5])	([5])
Stocks, Dec. 31	3.8	5.7	8.6	7.9
Commercial	3.7	5.3	4.9	4.8
Government	.1	.4	3.7	3.1

[1] Forecast. [2] Includes beginning commercial and Government stocks. [3] Includes donations and transfers to the military. [4] Includes shipments to territories and exports under the Food for Peace Program. [5] Less than 50 million pounds.

Data published currently in *Dairy Situation* (ESCS).

Figure 6J-4.--Milk production, number of cows, and milk per cow (left); milk supply, use, and stocks (right).



Ready-to-cook weight. Processed eggs converted to shell equivalent.

Per Capita Consumption of Poultry and Eggs

	1970	1971	1972	1973	1974	1975	1976	1977[1]	1978[2]
					Pounds				
Total poultry meat	48.5	48.9	51.0	49.2	50.0	49.2	52.5	54.1	57.6
Chicken	40.5	40.4	42.0	40.7	41.1	40.3	43.3	44.9	48.1
Broilers	36.9	36.7	38.4	37.4	37.5	37.2	40.4	41.7	45.0
Other	3.6	3.8	3.6	3.3	3.6	3.4	2.9	3.2	3.1
Turkey	8.0	8.4	9.0	8.5	8.9	8.6	9.2	9.2	9.5
					Number				
Eggs	310	312	305	291	286	280	274	272	273
Shell	276	275	269	260	252	249	241	235	237
Processed[3]	34	37	36	31	34	31	33	37	36

[1] Preliminary. [2] Forecast. [3] Shell equivalent of processed eggs.

Figure 6J-5.--Per capita consumption of poultry and eggs.

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Chapter 7 - Landscape Resources

Status

There is no inventory of the scenic landscapes in the Nation's countryside. Therefore, there are no precise figures on the loss of these scenic landscapes. Existing inventories are limited to federally managed areas, mainly wildlands or wilderness.

The public expects National Forests to appear natural, wild, and thus "scenic." As a result, excluding Alaska, more than 50 percent of the National Forest lands that have been inventoried are classified in terms of their visual resources. This amounts to approximately 73 million acres, as of March 1979 (USDA, 1979a).

Countryside scenic resources, primarily privately owned lands, form a major segment of the landscape that the National Trust for Historic Preservation has identified as possessing scenic qualities. But they have not yet been inventoried. The Trust has pursued a policy of conserving rural scenic resources since 1973 and is now launching a 3-year program focused on protecting "the beauty of America's countryside" (National Trust, 1979a).

The following discussion is based on estimates in the 1977 National Resource Inventories (USDA, 1978). These estimates show the following distribution of rural land uses, excluding Alaska:

	Acres (1,000)
Cropland	413,167
Pasture, native pasture, and rangeland	541,406
Forest land	369,700
Other	111,045
Total	1,435,318

Visual elements within the landscape (structures, vegetation, sky, water, landforms) and their relative juxtaposition determine scenic quality. Therefore, changes in rural land use that alter these visual elements affect the scenic quality of the rural landscape.

Urbanization, mining, transportation routes, water impoundments, and other factors are altering nonfederal rural land. From 1958 to 1967, about 10 million acres of rural land were converted to urban, built-up, and transportation uses. Between 1967 and 1977, another 34 million acres of rural land (including small built-up areas 1/4 to 10 acres in size) were converted to these same uses. Some portion of these 44 million acres probably possessed rural scenic qualities. However, there are no precise figures on the size of that portion.

It is not only the conversion of rural lands to nonrural uses that affects the landscape. Changes from one rural land use to another also influence scenic quality. The Potential Cropland Study (Dideriksen et al., 1977) shows that from 1967 to 1975, the use of land for pasture and rangeland increased

at the expense of forest land (62 million acres) and cropland (53 million acres). Changes in the rural landscape that eliminate forest land can significantly affect scenic qualities.

The same cropland study (Dideriksen et al., 1977) shows a significant in-and-out shift in the acres of cropland. From 1967 to 1975, 53 million acres of cropland shifted to pasture, while 32 million acres of pasture shifted to cropland. About 11 million acres of forest land were shifted into crop production, while 8 million acres of cropland were converted to forest land. In addition, 13 million acres of cropland shifted to other land or rural residences, but only 6 million acres of other land converted to cropland. All of these shifts may affect the landforms and vegetative cover in rural areas.

Condition

Although there are no statistics on the extent of the loss of rural or countryside scenic resources, there are general data on the extent to which the landscape has been altered by development and industrial activity. The ecological and economic impacts of these activities have been discussed in other parts of this appraisal; however, some statistics are repeated to emphasize how disturbed land affects landscape resources.

Mining

Mining activities often destroy vegetative cover, drastically reshape the surface of the land, destroy natural rock formations, alter or degrade water bodies, and generally disrupt the landscape. The Department of the Interior estimated that surface mining had disrupted 3.2 million acres of land prior to January 1, 1965 (USDI, 1967). This figure included only the acreage physically disturbed by the mining operation and did not reflect land disturbed by support activities or adjacent lands that were indirectly affected by mining.

SCS reported that 5.7 million acres of land were disturbed by mining as of July 1, 1977 (USDA, 1979b). Of this total, 1.9 million acres have been reclaimed in some manner. SCS also estimated that mining continued to disrupt land at the rate of 202,000 acres annually between January 1, 1965, and July 1, 1977.

Mining activities occur largely on lands classified as rural. From all indications, mining will increase in the future. New mining operations, regulated by P.L. 95-87, the Surface Mining Control and Reclamation Act of 1977, must have approved reclamation plans. About 2.7 million acres of existing mined lands, however, do not have to be reclaimed under any law and remain as eyesores in countryside landscapes.

Forest Land

Forest land stabilizes the soil and provides wood fiber, wildlife habitat, and recreation. Forest also provides visual variety and interest in many

landscapes. The removal of this cover and subsequent treatment of the land can drastically reduce the quality of rural scenic resources.

There are currently about 377 million acres of nonfederal forest land in the Nation (USDA, 1978). While there are no figures on how much forest is removed annually, current management practices indicate that at some time in the future nearly all of the nonfederal forest land will be used to produce wood fiber.

In addition to the runoff caused by removing vegetative cover, the landscape resource can be adversely affected by ancillary timber harvesting facilities such as logging roads, skid trails, and stream crossings. The remains of the harvesting such as stumps and slash can further diminish the quality of the landscape. Reforestation of cleared lands also affects the rural scenic landscape because the size, color, and rowed plantations of new vegetation differ from the size, color, and randomness of natural vegetative growth.

Urbanization

Statistics indicate that between 1970 and 1975 the United States population increased 6.3 percent in nonmetropolitan areas and only 3.6 percent in metropolitan areas (CEQ, 1977). However, this growth in nonmetropolitan areas is occurring largely in urban fringe which is extending into traditionally rural land.

Much of the urban growth is occurring in the South and West, while urban areas in northeast and north-central states are stagnant or experiencing emigration. The scenic resources of the traditionally rural South are probably undergoing some degree of disruption and destruction as a result of this urban growth. The Rocky Mountain States, also valued for their scenic qualities, have a similar problem. Their average annual growth rate is 3.1 percent or more than 3 times the national average (CEQ, 1977). Such growth is often occurring at the expense of landscape resources.

From 1967 to 1975, more than 8 million acres of prime farmland were converted to urban development, reservoirs, and other uses. The most severe losses occurred in the Southeast and Midwest where 3 million acres were converted during that period (USDA, 1977). In addition to the obvious loss of land for food and fiber production, conversions of farmland or rural lands to urban lands may drastically diminish the quality of landscape resources.

As with other land uses, the visual impact of urban land use goes beyond actual physical disturbance to indirect effects such as air pollution and interrupted vistas. The physical disturbances are numerous and complex: removal of vegetation, reshaping of land, altered drainage patterns, introduction of a disparate variety of building structures, and the influx of concentrated human activity. The total effect differs significantly from the forms, colors, and textures visually associated with cropland.

Water

The public's preference for water in the landscape is well documented. The Urban Land Institute conducted a survey on the potential benefits of lakes and ponds. The esthetic value of both new and existing lakes and ponds was the benefit that the public mentioned most (ULI, 1976).

Modifications of existing or created water bodies have marked effects on scenic resources in rural and suburban settings. Modifications that sometimes have negative visual effects in certain landscapes include geometric alignments, discoloration of water from construction or mining, abrupt transitions from land to water, and structures that have disruptive contrasts in texture, color, and form.

Streams and Rivers.--The alteration of streams and rivers has traditionally been a part of water management. Modifications such as dams, levees, channel work, and dredging often disrupt landforms (sideslopes, maintenance berms), riparian vegetation, streambed configuration, and, in general, the scenic quality of the stream itself. Access roads and other ancillary structures that are often a part of these modifications frequently damage the entire corridor of a stream or river.

In addition to providing visual variety in certain landscapes, the natural configurations of streams and rivers have important functions. Irregular edges and streambeds often check surface erosion; aid in water absorption, percolation, and transportation of nutrients; and provide food and cover for wildlife and fish.

Lakes and Reservoirs.--In 1967, the area covered by reservoirs in the United States approached 5 million acres (Stanberry, 1967). At present there are about 49,000 large reservoirs and more than 2 million small reservoirs. The construction of reservoirs and development around both lakes and reservoirs can have a variety of effects on scenic resources. Some frequently negative effects are 1) removal or inundation of vegetation; 2) visually incompatible structures, visible borrow areas, and roads; 3) degradation of the landscape because of excessive recreation use; and 4) disruption of the land/water transition area (second home development, urbanization, access points and extreme drawdowns that disrupt shoreline appearance and vegetation). Some positive effects are the creation of features such as islands and peninsulas and the enhancement of shoreline vegetation or geologic features.

Small Water Bodies.--A recent SCS survey indicated that in the United States there are about 1.2 million acres of water bodies that cover less than 2 acres and 3.5 million acres of water bodies that cover 2 to 40 acres (USDA, 1978). Small water bodies constitute a major landscape resource. The shorelines, bank slopes, siting, and shoreline vegetation of these ponds can have a positive effect on scenic resources. However, there are often problems caused by uncontrolled access by animals and low water levels.

Uncontrolled Recreation

Uncontrolled recreation on both federal and nonfederal lands continues to grow. In many cases, it degrades landscape resources. The most widely publicized problem is the use of off-road vehicles (ORV's). The Bureau of Land Management (BLM) estimated in 1977 that more than 10 million people used almost 5.5 million motorcycles off-road on both public and private lands. The agency also estimated that there were more than 6.5 million snowmobiles in use. There were no statistics available on off-road use by 4-wheel drive vehicles (CEQ, 1977).

ORV's are used in a wide variety of landscapes, including deserts, sand dunes, pastureland, forest land, and fragile stream ecosystems. Their use is by no means restricted to wildlands. Evidence of ORV activity can be found throughout the American countryside. Whether a site is used by ORV's depends on the vegetative cover and terrain. In some areas, the continued use of ORV's destroys vegetation and wildlife habitat and contributes to erosion, gullying, and degraded water quality.

Other forms of uncontrolled recreation which can harm the landscape resources in rural areas include spontaneous boat landings, campsites, and informal trails.

Agricultural Activities

Agriculture has undergone tremendous technological changes in recent years. These changes have resulted in larger farms, complex machinery, sophisticated transportation and communication systems, and a variety of new farm-related structures. The rural landscape is no longer dotted with family farm houses, red barns, white fences, green pastures, and grazing animals. To a large extent, the countryside has become industrialized. The physical reflection of this industrialization diminishes rural scenic resources. The introduction of agricultural structures that contrast in color, scale, form, and texture with the surrounding landscape is drastically changing the appearance of rural America.

Conservation practices are also affecting landscape resources. Field windbreaks, tree plantings, and hedgerow plantings introduce woody vegetation which improves visual variety in some landscapes. Field borders, vegetation to protect heavily used areas, channel vegetation, and critical area plantings to control erosion also introduce or modify vegetative patterns. Clearing land and harvesting woodland remove vegetation that may be reducing noise, controlling dust, and deflecting wind.

Water control or waste storage structures can introduce incompatible forms, colors, scale, and textures into rural landscapes. Terraces, channels, ditches, ponds, and dikes modify landforms. Water bodies that are introduced or altered vary in configuration, depth, width, side slopes, and alignment. Ditches, ponds, channels, waste treatment lagoons, and impoundments change the pattern of water and vegetation in rural landscapes.

Utility and Transportation Corridors

Utility installations and transportation corridors (highways, rails, pipelines, etc.) are generally permanent fixtures that have lasting effects on the countryside landscape. Factors such as route alignment, the siting of structures, right-of-way clearings, construction scars on vegetation and landforms, and the design, color, and structure of support facilities have important effects on landscapes. These effects should be considered in planning structures for utilities and transportation.

Trend

The mounting concern for the protection of rural scenic resources is documented. There is a national movement by both public and private entities to acquire and preserve nonfederal scenic areas in rural landscapes. The private sector seems to be spearheading the effort since most of the remaining unprotected scenic land is privately owned. The National Association of Conservation Districts reported that, as of 1977, the private sector had protected 951,095 acres of natural/scenic areas (NACD, 1977).

Nonprofit organizations have assumed an important role in protecting endangered, fragile, and scenic landscapes. In Lincoln, Massachusetts, a group of citizens formed the Rural Land Foundation and purchased a 109-acre farm for its historic value and to preserve its rural character (National Trust, 1979b). National nonprofit organizations such as the Trust for Public Land and the National Trust for Historic Preservation are developing special expertise and programs to promote and assist the preservation of agricultural and rural lands.

The National Trust recently distributed a fact sheet on rural conservation. It presented a summary of the planning tools, controls, and incentives available to assist local organizations and governments in effective planning. These tools include zoning; farmland retention through agricultural districts or use-value assessment; and regulation of natural and cultural resources through legislation, property acquisition (land banking, land trusts), easements, and the acquisition of development rights (National Trust, 1979b).

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PART III - LEGISLATIVE AUTHORITIES

Chapter 8 - Federal Laws

Introduction

This chapter discusses the major provisions of the federal laws which give USDA the authority to carry out its conservation activities for soil, water, and related natural resources. Many other laws affect USDA conservation activities, the most notable example being the National Environmental Policy Act (NEPA). However, this discussion is limited to federal laws that give authority to the Secretary of Agriculture. Laws which primarily provide authority to other agencies are not listed, even though they may directly affect USDA conservation activities. The laws listed here are grouped generally according to resource concerns and the activities of USDA. Readers interested in a particular topic such as flood control can refer to the listing that follows this introduction to find the basic USDA authorities for this activity. Bear in mind, however, that this report does not present a complete cross reference. Therefore, authorities for activities very closely related to flood control may be found in other sections such as watershed protection, river basins, wetlands, loan programs, resource conservation and development, and several others.

Federal Laws by Subject Area

Soil and Water Conservation

On April 27, 1935, after passage by both Houses without a dissenting vote, the President approved Public Law (PL) 74-46, 49 Stat. 163, 16 U.S.C. 590(af), "an Act to provide for the protection of land resources against soil erosion, and for other purposes." This law specifically established within the Department of Agriculture a "Soil Conservation Service" to develop and maintain a continuing program of soil and water conservation. Since the law provided that existing organizations should be used to form the new agency, the Acting Secretary of Agriculture ordered that the Soil Erosion Service become the Soil Conservation Service (SCS) with status as a regular bureau of the Department (Memorandum 673, April 27, 1935).

In February 1936, PL 74-46 was amended by PL 74-461, 49 Stat. 1148, 16 U.S.C. 590 (g, h, i-k, l-q.) which added provisions for SCS to make payments and grants of aid to carry out approved soil and water conservation measures. PL 74-461 entitled the entire authority the "Soil Conservation and Domestic Allotment Act."

Because of new legislative authorities that followed in rapid succession, new Departmental assignments, and an "old business" workload that continued to accelerate, SCS moved within a few years from an erosion-control agency to one with numerous programs.

On October 6, 1938, the Secretary of Agriculture realigned USDA functions and specifically assigned to SCS the drainage and irrigation investigations formerly conducted by the Bureau of Agricultural Engineering. The Agricultural Appropriations Act for fiscal year 1940, Public Law 76-159, 53 Stat. 939, 973 (June 30, 1939), and subsequent appropriations acts have provided the authorities for SCS drainage and irrigation activities. Secretary's Memorandum 782 of October 6, 1938, also consolidated in SCS all soil erosion, flood control, and related activities involving actual physical work on farmland, predominantly agricultural watersheds, and certain other areas.

Soil Conservation Districts

On June 5, 1935, the Secretary of Agriculture's Committee on Soil Conservation recommended: "That on or after July 1, 1937....all erosion control work on private lands, including new demonstration projects, be undertaken by the Soil Conservation Service only through legally constituted Soil Conservation Associations...." Out of this recommendation, the soil conservation district was born. In February 1937, the President submitted to the governors of all states "A Standard Soil Conservation Districts' Law," with suggestions that farmers and ranchers be given authority to organize districts specifically for conservation of soil and water resources. (See chapter 9, Soil Conservation Districts.)

Soil Surveys

In addition to Public Law 74-46, there are authorities for making soil surveys in the Agricultural Appropriations Act of 1896 and subsequent appropriations acts.

Secretary's Memorandum 1318 (October 14, 1952), consolidated all the Department's survey work and placed it in SCS. This work includes soil mapping, classification, correlation, and interpretation, and related laboratory services, map compilation, and publications.

In addition, Public Law 89-560, 80 Stat. 706, 42 U.S.C. 3271-3274 (September 7, 1966), directs the Secretary of Agriculture to make available soil surveys that are needed by states and other public agencies, including community development districts. Soil surveys are to provide guidance for community planning and resource development, along with serving a variety of other purposes. The Secretary's general authority to acquire and disseminate such useful agricultural information is contained in 7 U.S.C. 2201.

Snow Surveys

On July 1, 1939, the Division of Irrigation, formerly the Bureau of Agricultural Engineering, was transferred to SCS. This Division had been responsible for snow surveys. Secretary's Memorandum 870 (July 1, 1940), made SCS responsible for these surveys and for conducting research on the relation between weather and soil erosion.

In November 1953, Reorganization Plan No. 2 of 1953, 18 F.R. 3219, 67 Stat. 633, transferred all SCS research activities to the Agricultural Research Service. However, SCS retained its snow survey activity which is described as follows in USDA Administrative Regulations 1 AR 180, chapter 2, item f, page 50:

> Responsibility for making and coordinating snow surveys in the western States and Alaska and preparing forecasts of seasonal water supplies in affected streams, for the purpose of relating available water supply to agricultural plans and operations.

Inventory and Monitoring

The Agriculture Appropriation Act for the fiscal year beginning July 1, 1929, gave the Department of Agriculture authority to carry out inventory and monitoring activities. This act provided funds ($100,000) for the Secretary to investigate the causes of soil erosion and the possibility of increasing rainfall absorption and to devise means to preserve soil and prevent or control destructive erosion. This was to be accomplished independently or in cooperation with other branches of government, state agencies, counties, farm organizations, associations of businessmen, or individuals.

PL 74-46 gave SCS its basic authority to conduct surveys, investigations, and research relating to soil erosion and measures to prevent it.

The Secretary of Agriculture's Memorandum 1396 (April 10, 1956) established the National Inventory of Soil and Water Conservation Needs. This inventory was made for each county in the United States. SCS conducted the original inventory in 1958 and updated it in 1967.

Public Law 92-419, 86 Stat. 657, 670, 7 U.S.C. 1010a (August 30, 1972), authorized a land inventory and monitoring program. This program includes, but is not limited to, identifying prime agricultural producing areas and flood plains and studies and surveys of erosion, sediment damage, and land use changes and trends. The law also directed the Secretary of Agriculture to issue a land inventory report on the Nation's soil, water, and related resources every 5 years.

Plant Materials Centers

The plant materials work now conducted by SCS started in the Erosion Nurseries of USDA's Bureau of Plant Industry in 1934. On March 25, 1935, in Department Memorandum 665, the Secretary consolidated all USDA erosion control activity in the Soil Erosion Service. This included erosion control nurseries. Later, the Soil Conservation Act of 1935 which established SCS was amended by Public Law 78-425, 58 Stat. 734, 738, 16 U.S.C. 590f (September 21, 1944), to incorporate these nurseries into SCS.

In 1954, the nurseries' objective of quantity production of seeds and plants was changed to emphasize collection, evaluation, and field testing of plants for conservation use. The name "nurseries" was changed to "plant materials centers" at that time. SCS encourages commercial growers to produce plant materials in quantity for use in conservation programs. The SCS plant materials work supports the agency's programs and is not a research activity.

Agricultural Conservation Program

The Soil Conservation and Domestic Allotment Act, as amended by Public Law 74-461, 49 Stat. 1148, 16 U.S.C. 590g-590p(a), 590q (February 29, 1936), authorized the Agricultural Conservation Program (ACP). This program is administered by the Agricultural Stabilization and Conservation Service. The ACP is aimed at (1) the need to control erosion and sedimentation from agricultural land and to conserve the water resources on such land, (2) the need to control pollution from animal wastes, (3) the need to facilitate sound resources management systems through soil and water conservation, (4) the need to encourage voluntary compliance by agricultural producers with federal and state requirements to solve point and nonpoint sources of pollution, (5) national priorities reflected in the National Environmental Policy Act of 1969 and other congressional and administrative actions, (6) the degree to which the measures contribute to the national objective of ensuring a continuous supply of food and fiber necessary for the maintenance of a strong and healthy people and economy, and (7) the type of conservation measures needed to improve water quality in rural America.

The Agricultural Conservation Program was first funded by the Agriculture Appropriation Act of 1936. Costs are shared with individuals or groups of farmers, ranchers, and woodland owners who perform approved practices that conserve soil and water and reduce pollution.

Title X of the Agriculture and Consumer Protection Act of 1973, 93-86, 87 Stat. 241, 16 U.S.C. 1501 et seq. (August 10, 1973), provides cost sharing for soil and water conservation, pollution abatement, and other purposes

under the ACP. It also provides for an annual cost-sharing program and the development of long term agreements (3-10 years) based on conservation plans approved by soil conservation districts. The Soil Conservation Service is responsible for most conservation planning and related technical servicing. However, the Forest Service is responsible for forestry practices, except for windbreaks. Long term agreements covering an entire farm are not available in counties offering the Great Plains Conservation Program. The annual ACP cost-sharing program is available in all counties of the Nation. However, it is not available to Great Plains Conservation Program participants who sign a contract after January 1, 1979.

Flood Control

In the Flood Control Act of June 22, 1936 (Public Law 74-738, 49 Stat. 1570, 33 U.S.C. 701a et seq.), Congress recognized for the first time the importance of providing watershed protection and flood prevention as a complement to the Corps of Engineers' downstream flood control program. In this Act, the Congress authorized the Secretary of Agriculture to carry out surveys and investigations of watersheds and to install measures to retard runoff and waterflow and prevent soil erosion on watersheds.

The Water Facilities Act of 1937 authorized the Secretary of Agriculture to construct water storage and utilization projects for agriculture in arid and semiarid areas. Some of these projects were financed by loans from what was then the Farm Security Administration.

The Flood Control Act of December 22, 1944, Public Law 78-534, 58 Stat. 887, 33 U.S.C. 701-1 et seq., authorized the first installation of improvements in 11 watersheds. At that time, such projects were primarily accelerated land treatment. USDA's responsibility for flood control work was divided between SCS and the Forest Service. The 1951 USDA Appropriations Act permitted the 11 watershed projects to include channel work and structures to detain floodwater.

The Flood Control Act of 1944 also authorized the Secretary to undertake such emergency measures to retard runoff and prevent soil erosion as needed to safeguard lives and property from floods and the products of erosion on any watershed. The Secretary could institute these measures whenever fire or any other natural element of force had suddenly impaired a watershed. Section 216 of the Flood Control Act of 1950, Public Law 81-516, 64 Stat. 163, 184, 33 U.S.C. 701b-1 (May 17, 1950), increased the funding for emergency measures from the $100,000 contained in the Flood Control Act of 1944 to $300,000.

In Memorandum 1325 (April 1, 1953), the Secretary made SCS responsible for administering all the Department's flood prevention and river basin activities. Under this assignment, SCS develops standards and procedures for flood prevention work, plans and schedules watershed surveys, and installs flood prevention measures.

The Agricultural Appropriations Act for fiscal year 1956, Public Law 84-40, 69 Stat. 51, 54 (May 23, 1956), authorized the use of flood prevention funds for gully control, floodwater detention, and floodway structures.

Appalachian Land Stabilization and Conservation Program

The Appalachian Regional Development Act of 1965, Public Law 89-4, 79 Stat. 5, 12 (March 9, 1965), established development programs in the Appalachian region, including the Appalachian Land Stabilization and Conservation Program. The program is to provide for the control and prevention of erosion and sediment damages and promote the conservation and development of the soil and water resources in the Appalachian region.

Cost sharing and technical assistance are provided to landowners, operators, and occupiers for land stabilization, erosion and sediment control, and other conservation and development measures. Farmers enter into a long-term (3-10 years) contract for the cost sharing available at 80 percent of the cost. Assistance under a contract is limited to 50 acres of land on the eligible farm.

The program is administered by the Agricultural Stabilization and Conservation Service (ASCS) through its state and county offices. The Soil Conservation Service is responsible for the conservation planning and related technical servicing. The contracts are based on conservation farm plans. Technical assistance for forestry practices is furnished by the Forest Service.

Funds for the program are appropriated to the Appalachian Regional Commission. The state program and/or projects are developed cooperatively by the state government and USDA agencies. When approved by the Appalachian Regional Commission, funds are transferred to the ASCS for administration. There has been little funding of new contracts since 1972, except for certain demonstration projects in Pennsylvania and for restoring mined lands. The Appalachian Commission has indicated a potential for approving and funding new special projects.

Watershed Protection

The Agriculture Appropriations Act of 1954, Public Law 83-156, 67 Stat. 214 (July 28, 1953), appropriated money for watershed protection under the authority in Public Law 74-46. This money was used to initiate the small watershed "pilot" projects.

The Watershed Protection and Flood Prevention Act, Public Law 83-566, 68 Stat. 666, 16 U.S.C. 1001 et seq., was approved by the President on August 4, 1954. SCS was designated as the action agency with primary responsibility for USDA's cooperation with local organizations in small watersheds throughout the Nation. The Act terminated USDA activities under the Omnibus Flood Control Act of 1936, as amended and supplemented, except for completion of works of improvement in the 11 authorized watershed improvement programs and emergency measures to retard runoff and prevent soil erosion.

Amendments to PL 83-566 in 1956, 1958, 1960, 1961, 1962, 1965, 1968, 1972, 1974, and 1977 provided for the following:

1. Public Law 84-1018, 70 Stat. 1088, 16 U.S.C. 1001 et seq. (August 7, 1956):

a. Required the Federal Government to pay 100 percent of the construction cost for flood prevention.

b. Eliminated provisions which limited works of improvement to agricultural phases of conservation, development, utilization, and disposal of water.

c. Increased the limits on the total capacity of any single structure from 5,000 acre-feet to 25,000 acre-feet.

d. Excluded single structures which detain more than 5,000 acre-feet of floodwater.

e. Authorized the Farmers Home Administration to make watershed loans to sponsoring organizations.

f. Extended the program to Hawaii, Alaska, Puerto Rico, and the Virgin Islands.

2. Public Law 85-624, 72 Stat. 563, 567, 16 U.S.C. 1008 (August 12, 1958), provided for coordination with the Secretary of the Interior on the fish and wildlife aspects of watershed projects.

3. Public Law 85-865, 72 Stat. 1605, 16 U.S.C. 1004 (September 2, 1958), authorized cost sharing for fish and wildlife purposes.

4. Public Law 86-468, 74 Stat. 131, 16 U.S.C. 1006a (May 13, 1960), extended the provisions of Public Law 83-566 for additional works in the 11 watershed improvement programs authorized by section 13 of the Flood Control Act of 1944.

5. Public Law 86-545, 74 Stat. 254, 16 U.S.C. 1004 (June 29, 1960), inserted provisions requiring local organizations to provide assurances on the interests in land being acquired through condemnation.

6. Public Law 87-170, Stat. 408, 16 U.S.C. 1002 (August 30, 1961), expanded the definition of local organizations to include irrigation or reservoir companies, water users' associations, and similar organizations not operated for profit.

7. Public Law 87-703, 76 Stat. 605, 608, 16 U.S.C. 1004 et seq. (September 27, 1962), provided for recreational cost sharing, advancement of acquisition funds for site preservation, and the advancement of funds to develop water supplies for future municipal and industrial use in any multiple purpose reservoir.

8. Public Law 89-337, 79 Stat. 1300, 16 U.S.C. 1002 (November 8, 1965), expanded the upper limit on the capacity of single structures which detain floodwater from 5,000 acre-feet to 12,500 acre-feet.

9. Public Law 90-361, 82 Stat. 250, 16 U.S.C. 1005 (June 27, 1968), authorized the Secretary of Agriculture to administer contracts for the construction of works of improvement upon the request of local organizations.

10. Public Law 92-419, 86 Stat. 657, 667, 16 U.S.C. 1001 et seq. (August 30, 1972), authorized certain technical and financial assistance to public bodies for programs dealing with (1) water quality management, (2) conservation and proper utilization of land to control agriculture-related pollution and disposal of solid wastes, (3) municipal and industrial water supplies, and (4) ground water recharge. It also permitted use of other federal funds for land rights and long term contracting for land treatment (assistance to individuals). The Act instituted interagency coordination between USDA and the Environmental Protection Agency and the Department of Health, Education, and Welfare for those aspects of plans dealing with water quality and public health.

11. Public Law 93-251, 88 Stat. 12, 33 U.S.C. 701b-11 (March 7, 1974), stated that consideration must be given to nonstructural alternatives in any flood prevention project.

12. Public Law 95-113, 91 Stat. 913, 1022, 16 U.S.C. 1002 et seq. (September 29, 1977), increased the amount USDA could spend on projects without obtaining Congressional approval to $1,000,000 and it increased its loan authority to $10,000,000.

River Basins

Public Law 83-566 and its 1956 amendment authorized USDA to conduct river basin studies with federal, state, and local agencies. These studies assist in appraising water and related land resources and formulating alternative plans for land treatment and nonstructural or structural measures which meet public needs and objectives. The Soil Conservation Service provides leadership for USDA participation in these studies. Other USDA agencies involved are the Forest Service and the Economics, Statistics, and Cooperatives Service.

In 1962, Public Law 87-639, 76 Stat. 438 U.S.C. 1009 (September 5, 1962), authorized the Secretary of the Army and the Secretary of Agriculture to make joint surveys of watersheds for flood control and conservation and to prepare joint reports for Congress to obtain authorization for recommended works of improvement. The Soil Conservation Service works with the Corps of Engineers in these joint investigations and arranges for and coordinates participation by other USDA agencies.

The Water Resources Planning Act, Public Law 89-80, 79 Stat. 244, 42 U.S.C. 1962 et seq. (July 22, 1965), provided for the conservation, development, and utilization of water and related land resources on a comprehensive, coordinated basis by the federal, state, and local governments. It established the Water Resources Council (WRC), of which the Secretary of Agriculture is a member. The Council has assigned responsibility for carrying on much of its work and for staffing to a council of member alternates.

The Soil Conservation Service is the USDA member on the WRC Interagency Liaison Committee. It also provides staff assistance to the USDA Member and Alternate on the Council and to the Council itself.

Title II of this Act authorized the formation of River Basin Commissions with members from federal agencies, including USDA, and from each state and interstate agency. The River Basin Commissions are to:

1. Coordinate federal, state, interstate, local, and nongovernmental plans for water and related resources.

2. Prepare joint plans and alternatives which are comprehensive and coordinated for water and related resources.

3. Recommend schedules and priorities for collecting data and investigating, planning, and constructing projects.

4. Foster and undertake studies on water and related land resources.

An SCS state conservationist is designated as the USDA member of each River Basin Commission and of each River Basin Interagency Commission which operates under WRC. The USDA members represent the Department and its interests in Commission activities and coordinate USDA participation.

Rural Development

Public Law 74-46 and directives from the Secretary of Agriculture have made SCS responsible for providing leadership for soil and water conservation. All programs with which SCS is associated also make a contribution to the development and upgrading of rural America. These programs involve local people who help make them responsive to local community needs. Executive Order No. 11493, November 13, 1969, established a Cabinet-level Council for Rural Affairs to recognize the importance of rural America to the national economy and to society. The objective was to provide nonfarm employment, income opportunities, and more attractive living conditions in nonmetropolitan areas of the Nation. Executive Order No. 11541, July 1, 1970, established the Domestic Council and eliminated the Rural Affairs Council. The Domestic Council assumed the responsibility formerly vested in the Rural Affairs Council.

Secretary's Memorandum 1667 on the Rural Development Program (November 7, 1969) established USDA's organizational structure for carrying out its role in rural development. It directs all agencies in the Department to give aggressive leadership and assistance to the Rural Development Program, which is aimed at making rural communities economically and socially viable.

Section 603(a) of the Rural Development Act of 1972 made rural development part of the mission of USDA. It directs the Secretary to give aggressive leadership to rural development through the Department's agencies. Current Administration policy assigns the Farmers Home Administration leadership

for improving the economic conditions of the rural poor, aged, and minorities.

Great Plains Conservation

On August 7, 1956, the President signed an amendment to the Soil Conservation and Domestic Allotment Act and the Agricultural Adjustment Act of 1938, authorizing the Great Plains Conservation Program (GPCP). This amendment (Public Law 84-1021, 70 Stat. 1115, 16 U.S.C. 590p) authorized USDA to give long term technical and cost-sharing help to Great Plains farmers and ranchers.

Public Law 86-793, 74 Stat. 1030, 16 U.S.C. 590p (September 14, 1960), amended Section 16(b) of the Soil Conservation and Domestic Allotment Act adding Sections 3 and 4. This amendment preserves a farmer's historic base for acreage allotments on cultivated cropland, even if cropland has been shifted to grass or other permanent vegetation under GPCP.

Public Law 87-129, 75 Stat. 319 (August 10, 1961), extended the Great Plains Conservation Program for 10 years to December 31, 1971.

Section 602(g) of the Food and Agriculture Act of 1965, Public Law 89-321, 79 Stat. 1187, 1208, 16 U.S.C. 590p (November 3, 1965), repealed Sections 3 and 4 that dealt with decreases in cropland during the period of a contract and the use of land converted to permanent vegetation in determining acreage allotments.

On November 18, 1969, the Act was again amended to extend the GPCP another 10 years to December 31, 1981 (Public Law 91-118, 83 Stat. 194, 16 U.S.C. 590p). The amendment also increased the limit on the total cost of the program from $150 million to $300 million, extended the program to nonfarm lands, and permitted contracts under annual leasing arrangements. It allowed a GPCP plan to include practices and measures for enhancing fish, wildlife, and recreation resources; promoting economic use of land; and reducing or controlling agricultural pollution. This amendment directed that conservation plans be developed in cooperation with conservation districts and authorized the Secretary to modify earlier contracts to provide equitable treatment with respect to similar conservation, land use, or commodity programs that USDA administers. In addition, it required the Secretary to consider the recommendations of soil and water conservation district boards before requiring contract forfeitures.

Resource Conservation and Development

Qualified local sponsors can initiate and sponsor Resource Conservation and Development (RC&D) areas with the assistance of USDA agencies under the following authorities: Public Law 75-210, 7 U.S.C. 1010; Public Law 87-703, 76 Stat. 607; Public Law 89-796, 80 Stat. 1478; Public Law 91-343, 84 Stat. 439; Public Law 92-419, 86 Stat. 669 (7 U.S.C. 1010-1011); Public Law 74-46, 49 Stat. 163 (16 U.S.C. 590af, q), 7 CFR 2.62.

The Food and Agriculture Act of 1962, Public Law 87-703, 76 Stat. 607, 7 U.S.C. 1010-1011e (September 27, 1962), authorized the Secretary to cooper-

ate with federal, state, territorial, and other public agencies and local nonprofit organizations to develop plans for land conservation and use and to assist them in carrying out such plans through loans. The Act permits no loan in excess of $250,000 without prior Congressional committee approval.

Secretary's Memorandum 1665 (October 9, 1969) assigned leadership for Resource Conservation and Development to the Soil Conservation Service. This memorandum superceded Secretary's Memorandum 1515 and merged the Farmers Home Administration's rural renewal areas into the Resource Conservation and Development Program (RC&D).

Public Law 91-343 (July 18, 1970), 84 Stat. 439, 7 U.S.C. 1011e, added provisions authorizing the Secretary to bear an equitable share of the costs of installing works of improvement for public works on water-based fish and wildlife and recreation developments. It also authorized the Secretary to bear all engineering and other technical costs and up to one-half the cost of landrights. But it limited the federal contribution to one work of improvement for each 75,000 acres in any project. Assistance can only be given if none is provided under any other existing authority and the project is consistent with any statewide outdoor recreation plan adequate for the purposes of the Land and Water Conservation Act of 1965.

Public Law 92-419 authorized the Secretary to provide rural communities with assistance and a proportionate share of the cost for:

1) installing measures and facilities for water quality management;
2 storage of rural community water supplies and water quality management;
3) control and abatement of agriculture-related pollution;
4) disposal of solid wastes; and
5) storage of water in reservoirs, farm ponds, or other impoundments, together with necessary water withdrawal appurtenances for rural fire protection.

The Food and Agriculture Act of 1977, Public Law 95-113, 91 Stat. 913, 1022 (September 29, 1977), increased the RC&D loan authority to $500,000 and authorized expenditures for the conservation, development, and utilization of water for aquaculture.

The Farmers Home Administration is responsible for making and servicing loans in RC&D areas. Other responsibilities are assigned to the Agricultural Stabilization and Conservation Service; Economics, Statistics, and Cooperatives Service; Science and Education Administration; Forest Service; and the Rural Electrification Administration.

Public Law 74-46 authorizes SCS to provide technical and financial assistance for planning and installing soil and water conservation measures. This includes erosion and sediment control and flood prevention. Annual appropriation acts based on Public Law 74-46 also authorize technical and financial assistance for farm irrigation and land drainage and special measures to manage soil and water to control agricultural pollutants.

Rural Abandoned Mines

Section 406 of the Surface Mining Control and Reclamation Act of 1977, Public Law 95-87, 91 Stat. 460, 30 U.S.C. 1236 (August 3, 1977), authorized the Secretary to enter into agreements (contracts) with landowners and users to reclaim abandoned or inadequately reclaimed coal-mined lands and waters and lands affected by past mining. Participants in this program must furnish a conservation and development plan that sets forth the conservation treatment required and their proposed land uses after reclamation. This plan is incorporated into a contract whereby the participants agree with the Secretary to effect the conservation treatment and land uses provided for in the plan. In return for this contract, the Secretary is authorized to furnish financial and technical assistance for applying the planned land use and conservation treatment. The Act directs the Secretary to use the services of SCS in carrying out Section 406.

Rural Clean Water

The Clean Water Act of 1977, Public Law 95-217, 91 Stat. 1579, 33 U.S.C. 1288 (December 27, 1977), amended Section 208 of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). It established a Rural Clean Water Program (RCWP). Section 208(j) of the Act authorized the Secretary of Agriculture, with the concurrence of the Administrator, Environmental Protection Agency, to establish and administer a program based on 5- to 10-year contracts with rural landowners and operators. These contracts promote the installation and maintenance of best management practices to control water pollution from nonpoint sources. The law directs the Secretary to act through SCS and such other agencies as he may designate. The program provides financial and technical assistance through cost sharing for those practices that improve water quality and are consistent with the areawide waste treatment management plan.

Resources Conservation Act

The Soil and Water Resources Conservation Act of 1977, Public Law 95-192, 91 Stat. 1407, 16 U.S.C. 2001, et seq. (November 18, 1977), authorized the Secretary of Agriculture to utilize SCS to conduct a continuing appraisal of the soil, water, and related resources of the Nation. In addition, the Act requires SCS to develop a soil and water conservation program based on this appraisal. This program will direct future USDA conservation efforts and guide SCS activities that are part of those efforts. The purpose of the Act is to ensure that USDA programs for conserving our soil, water, and related resources are responsive to the long-term needs of the Nation.

Salinity Control

Title I of the Colorado River Basin Salinity Control Act, Public Law 93-320, 88 Stat. 266, 43 U.S.C. 1571 et seq. (June 24, 1974), authorized the Secretary of the Interior to transfer funds to the Secretary of Agriculture. These funds are to provide technical assistance to farmers for conducting research and demonstration projects and related investigations on how to achieve greater onfarm irrigation efficiency in the Wellton-Mohawk Irrigation and Drainage District, Yuma, Arizona.

Title II covers measures upstream from the Imperial Dam and directs the Secretaries of Agriculture and the Interior and the Administrator of the Environmental Protection Agency to coordinate their activities to meet the salinity control objective of this law. Title II directed the Secretary of the Interior to enter into agreements with the Secretary of Agriculture to develop a unified control plan for the Grand Valley Unit in Colorado to reduce the seepage of irrigation water back into the Colorado River. The Secretary of Agriculture was directed to cooperate in the planning and construction of onfarm system measures under programs available to the Department. Based on the Agriculture Appropriation Act for 1979, the ASCS, SCS, and SEA-ES are now cooperating in a project for onfarm installation of water conservation measures for carrying out of water management plans.

Recreation

The Food and Agriculture Act of 1962, Public Law 87-703, 76 Stat. 605 (September 27, 1962), opened the way for expanding outdoor recreational facilities on privately and publicly owned rural lands. It established some new recreation authorities for the Agricultural Stabilization and Conservation Service (Cropland Conversion Program), the Soil Conservation Service (Small Watersheds Program, Public Law 83-566), and the Farmers Home Administration.

Secretary's Memorandum 1516 (November 2, 1962) made SCS responsible for USDA leadership and liaison with other agencies and groups in activities relating to income-producing recreation.

Public Law 91-343, 84 Stat. 439, 7 U.S.C. 1011e (July 18, 1970), provides for recreation assistance under the Resource Conservation and Development Program. (See the section on Resource Conservation and Development.)

Wetlands

The Water Bank Act, Public Law 91-559, 84 Stat. 1418, 16 U.S.C. 1301 et seq. (December 19, 1970), established the Water Bank Program to conserve surface waters; to preserve and improve habitat for migratory waterfowl and other wildlife resources; and to preserve, restore, and improve wetlands. Beginning in 1971, USDA entered into agreements with landowners and operators to conserve specified wetlands in important migratory waterfowl nesting and breeding areas. The agreements are for 10-year periods with provisions for renewals for additional periods.

The Agricultural Stabilization and Conservation Service has administrative responsibility through its state and county committees. The Soil Conservation Service is responsible for conservation planning and related technical servicing. The 10-year agreements are based on conservation plans developed with local soil conservation districts.

The 1972 Water Bank Program operated in 56 counties in 13 states. The 1973 program was terminated by the Administration on December 22, 1972, but it was reactivated in March 1974. In 1978, the program included 172 counties in 15 states.

Foreign Assistance

The Foreign Assistance Act of 1961, Public Law 87-195, 75 Stat. 424 (September 4, 1961), authorized federal agencies to provide technical assistance to help foreign countries improve their standards of living and economic conditions. This assistance is financed by funds from the Agency for International Development (AID).

In a cooperative agreement between the Secretary of Agriculture and the Director of AID dated February 15, 1966, provisions were made for USDA, including SCS, to assume necessary assignments in foreign agricultural development.

Flood Insurance

The flood insurance responsibilities of SCS are covered in Chapter III, Title XIII of the National Flood Insurance Act of 1968, Public Law 90-448, 82 Stat. 587 (August 1, 1968). Section 1360 authorizes the Department of Housing and Urban Development (HUD) to enter into agreements with the Department of Agriculture to identify, map, and provide information on flood prone areas. In addition, Section 1371 authorized interagency agreements to allow USDA to undertake studies on any other natural disaster, such as an earthquake, mud slide, or other peril. The Soil Conservation Service has carried out studies on a reimbursable basis under annual interagency agreements with HUD.

Flood Hazard

SCS conducts flood hazard studies under the provisions of Section 6 of Public Law 83-566, 68 Stat. 666, in accordance with Recommendation 9(c), House Document 465, 89th Congress. SCS conducts surveys and investigations and then prepares reports to guide local governments in preparing sound flood plain management programs, including appropriate flood plain regulations.

Wildlife

Public Law 73-121, 48 Stat. 401, 16 U.S.C. 661-666, (March 10, 1934), authorized the Secretaries of Agriculture and Commerce to provide technical assistance for rearing, stocking, and increasing the supply of game, fur-bearing animals, and fish. It also authorized assistance for combating diseases in these animals and the development of a program to conserve and rehabilitate wildlife. An amendment to this Act expanded it and entitled it the Fish and Wildlife Coordination Act. Reorganization Plan No. II of 1939 transferred the functions of the Secretary of Agriculture relating to wildlife conservation under this Act to the Secretary of Interior.

USDA's authority for carrying out activities to conserve wildlife on private land is contained in Public Law 74-46, 49 Stat. 163, 16 U.S.C. 590af (April 27, 1935). Other USDA authorities which make specific reference to wildlife are discussed under the following sections in this chapter:

Agricultural Conservation Program
Watershed Protection

River Basins
Resource Conservation and Development
Rural Abandoned Mines
Wetlands

Coastal Zone Management

The Coastal Zone Management Act of 1972, Public Law 92-583, 86 Stat. 1280, 16 U.S.C. 1451 et seq. (October 27, 1972), authorized a national policy and the development of a national program for our coastal zones. The Act directed that this program provide for the management, beneficial use, protection, and development of the land and water resources of the Nation's coastal zones.

The Department of Commerce is responsible for this program through its Office of Coastal Zone Management. Planning activities in the 30 states participating in the program have led to increased requests for resource data and planning assistance. In keeping with its commitment to rural development through conservation districts, SCS provides assistance to this program.

Loans

A number of laws authorize the Farmers Home Administration to make loans to individuals seeking to conserve soil, water, and related resources:

1. Operating Loans - Public Law 95-334, 7 U.S.C. (1941). These loans are primarily for farm operating expenses and the purchase of chattels. Farmers may use limited funds for seeding, sodding, fencing, drainage, and other conservation measures.

2. Farm Ownership Loans - Public Law 95-344, 7 U.S.C. (1922). In addition to the purchase of family farms, these loans can be used for land and water development, pollution control, fencing, drainage, sodding, irrigation, and forestry.

3. Soil and Water Loans - Public Law 95-334 and Public Law 92-419, 7 U.S.C. (1924). These loans are for soil conservation, water development and conservation, forestation or drainage of farmland, pasture improvement, and pollution abatement.

4. Irrigation and Drainage Loans - Public Law 92-419 and Public Law 95-334, 7 U.S.C. (1926). These loans are made to legally organized associations of farmers and rural residents for irrigation and drainage work.

5. Grazing Associations Loans - Public Law 92-419 and Public Law 95-334, 7 U.S.C. (1926). Nonprofit associations can obtain these loans to acquire and develop grazing land or convert land to grazing.

6. Recreation Loans - Public Law 92-419 and Public Law 95-334, 7 U.S.C. (1924). These loans can be used to develop land and water resources that are part of income-producing recreation enterprises on farms.

7. Watershed Loans - Public Law 92-419, 16 U.S.C. 1001. Local organizations can use these loans to protect, develop, and use the land and water resources in small watersheds. (See Watershed Protection.)

8. Resource Conservation and Development Loans - Public Laws 87-703 and 89-796, 7 U.S.C. 1010. Public agencies and nonprofit corporations in designated RC&D areas can use these loans to carry out approved measures. (See Resource Conservation and Development.)

9. Emergency Loans - Public Law 87-128, Public Law 87-832, Public Law 93-24, Public Law 93-237, Public Law 94-68, Public Law 95-344, 7 U.S.C. (1961). These are loans to repair damage caused by natural disasters. The Farmers Home Administration estimates that about 10 percent of these funds are used for conservation measures.

10. Economic Emergency Loans - Public Law 95-334, 7 U.S.C. (1961). This law provides loans to relieve hardship caused by economic stress in an area. Funds can be used for conservation measures.

Research

State agricultural experiment stations were established under the Act of 1887, 24 Stat. 440, 7 U.S.C. 361a. The McSweeny and McNary Act of 1928, 45 Stat. 699, 16 U.S.C. 581, gave research authority to the Forest Service. Public Law 74-46, Stat. 163, 16 U.S.C. 590a, gives the Science and Education Administration authority to conduct research in conservation.

The Agricultural Marketing Act of 1946, 60 Stat. 1087, 7 U.S.C. 1621-1627, gives USDA authority to conduct economic research in agricultural production, marketing, and distribution and to collect and disseminate statistics. The Economics, Statistics, and Cooperatives Service (ESCS) carries out these functions.

Public Law 79-733, 60 Stat. 1082, 7 U.S.C. 427 (1946), authorizes research on the conservation, development, and use of land, forest, and water resources for agriculture. The Science and Education Administration (SEA) cooperates with the state agricultural experiment stations in this research.

The scope of USDA's research was further extended by Public Law 95-113, 91 Stat. 983, 7 U.S.C. 3103 (September 29, 1977), Title XIV, the National Agricultural Research, Extension, and Teaching Policy Act of 1977. PL 95-113 reaffirms USDA's role as the lead agency in the Federal Government

for the food and agricultural sciences. It defines the agricultural sciences and agricultural research, extension, and teaching as distinct USDA missions. The Act provides for improving the coordination and planning of agricultural research. This includes identifying research needs, establishing priorities, and ensuring that high priority research is given adequate funding and that national research, extension, and teaching objectives are achieved. This law also directs that the results of agricultural research are to be effectively communicated and demonstrated to farmers, processors, handlers, consumers, and others. It establishes a competitive grants program for high-priority research to be carried out by scientific research workers and colleges and universities. The Act also authorizes grants for research facilities and fellowships to strengthen training and research.

Public Law 95-307, 92 Stat. 353, 16 U.S.C. 1642 (June 30, 1978), the Forest and Rangeland Renewable Resources Act of 1978, authorized the Forest Service to conduct investigations and experiments to obtain, analyze, develop, and disseminate scientific information on protecting, managing, and utilizing forest and rangeland.

Extension Education

The Smith-Lever Act of May 8, 1914 (Public Law 63-95, 38 Stat. 372, 7 U.S.C. 341-348) inaugurated cooperative federal-state programs in each state for extension education on subjects important to agriculture. Under this Act and subsequent amendments, USDA and the Agricultural Extension Services of the state Land Grant Universities have conducted a variety of cooperative extension education programs on soil and water conservation. Additional information on these programs is presented in chapter 11, Historical and Institutional Setting.

Public Law 95-306, 92 Stat. 349, 16 U.S.C. 1671, the Renewable Resources Extension Act of 1978, provides for an expanded and comprehensive extension program for renewable forest and rangeland resources. This educational program is to cover a broad range of renewable resources and related ordinances. The Act also requires that the needs for research on renewable resources be identified. It makes the state directors of cooperative extension programs and the heads of extension in eligible colleges and universities responsible for each state's extension program on renewable resources.

The Secretary is to prepare a 5-year extension program on renewable resources. The program is to coincide with the planning cycles for the Forest and Rangeland Renewable Resources Planning Act and the Soil and Water Resources Conservation Act. The Secretary is also to prepare an annual report on the program for Congress.

Emergency Conservation

The Third Supplemental Appropriation Act of 1957, Public Law 85-58, 71 Stat. 176, gave the Agricultural Stabilization and Conservation Service funds and authority to cost share measures to correct damage caused by natural disasters.

Public Law 95-334, Title IV, 16 U.S.C. 2204 (August 4, 1978), authorizes the Secretary of Agriculture to make payments to farmers to:

1. Carry out emergency measures to control wind erosion and rehabilitate farmland harmed by erosion or floods and other natural disasters.

2. Carry out emergency measures to conserve water.

3. Undertake emergency measures to retard runoff in impaired watersheds. (This authority has never been exercised.)

Regional Problems

Public Law 89-136, Title V, 79 Stat. 564, 42 U.S.C. 3185 (August 26, 1965), as amended by Public Law 90-103, Title II, 81 Stat. 266 (October 11, 1967), and Public Law 91-123, Title II, 83 Stat. 216 (November 25, 1969), authorizes USDA to cooperate with the Secretary of Commerce to assist economic development regions. Such assistance includes improving the conservation and utilization of natural resources in these regions.

Public Law 89-4, Title II, 79 Stat. 12 (March 9, 1965), authorizes the Secretary to enter into agreements of up to 10 years with landowners in the Appalachian region to stabilize land, control erosion, and reclaim land. The Agricultural Stabilization and Conservation Service is the lead agency for this activity. The Forest Service and Soil Conservation Service provide technical assistance, and the Farmers Home Administration provides loan service.

Forestry

The Organic Act of 1897, 30 Stat. 34, 35, 16 U.S.C. 473-482, authorized the Forest Service's timber, range, and outdoor recreation and wilderness programs. Weeks Law, Public Law 61-435, 36 Stat. 961, 16 U.S.C. 480, 500, 513-521, enacted in 1911, established the Land and Water Program administered by the Forest Service.

Public Law 95-313, 92 Stat. 365, 16 U.S.C. 2101-2107 (July 1, 1978), provides authority for the following Forest Service programs:

1. Section 3 -- Rural Forestry Assistance - which includes:

    a. Technical forestry assistance to landowners, including management plans.

    b. Technical assistance for tree nurseries.

    c. Technical assistance for tree improvement (forest genetics).

    d. Technical assistance for loggers and wood processors (forest products utilization).

2. Section 4 -- Forestry Incentives: Technical assistance to recipients receiving cost sharing. (The Agricultural Stabilization and Conservation Service is responsible for the financial aspects of this program.)

3. Section 5 -- Insect and Disease Control:

   a. Technical assistance to help landowners control insects and disease.

   b. Prevention and control measures.

4. Section 6 -- Urban Forestry Assistance: technical assistance to urban residents.

5. Section 7 -- Rural Fire Prevention and Control: financial and technical assistance to states and others to prevent, control, and put out fires.

6. Section 8:

   a. Management Assistance: personnel, fiscal, and organizational.

   b. Planning Assistance: forest resource planning.

   c. Technology Implementation: applying research results.

In carrying out this Act, the Secretary:

a. works through and cooperates with state foresters,

b. encourages coordination between states,

c. uses and encourages use of private consultants and organizations, and

d. coordinates activities with related USDA programs.

Programs are active in all 50 states, Puerto Rico, the Virgin Islands, the Commonwealth of the Northern Marianas, the Trust Territory of Pacific Islands, and other territories. State agency personnel generally provide the assistance to the public.

Public Law 93-378, 88 Stat. 476, 16 U.S.C. 1601 (August 17, 1974), the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended by Public Law 94-588, 90 Stat. 2949, 16 U.S.C. 1600 (October 27, 1976), and the National Forest Management Act of 1976, directs the Secretary to:

a. prepare and keep updated an assessment of forest and rangeland resources,

b. prepare and send a renewable resource program to the President,

c. maintain an inventory of resources in the National Forest System,

d. develop management plans for resources in the National Forest System, and

e. cooperate with states.

The President transmits the assessment, the program, and a policy statement to Congress for use in determining the budget.

The Relationship Between Conservation Objectives and Federal Laws

In their report "A Generalized Evaluation Approach for USDA Conservation Programs," the USDA Land and Water Conservation Task Force identified 14 existing objectives for USDA soil and water conservation programs. Table 8-1 relates these objectives to 16 major pieces of authorizing legislation, as amended. This body of legislation is the basis for USDA's existing authority to conduct soil and water conservation programs.

Table 8-1.--USDA soil and water conservation programs and their authorizing legislation

Authorizing legislation	Flood plains mgt.	Land reclama-tion	Water supply	Timber produc-tivity	Water-shed protec-tion	Wind erosion	Pasture, range prod.
Public Law PL 74-46 Soil Cons. & Dom. Allot. Act.		X	X	X	X	X	X
PL 83-566 Watershed Protec. & Flood Prev.	X		X	X	X	X	X
PL 78-534 Flood Control Act of 1940	X		X	X	X	X	X
PL 81-516 Flood Control Act of 1950					X		
PL 87-703 Food & Agriculture Act of 1962	X		X	X	X		
PL 84-1021 Amend. Soil Cons. Dom. Allot. Act.	X		X	X	X	X	X
PL 92-419 Rural Development Act of 1972	X	X	X	X	X	X	X
PL 95-217 Clean Water Act of 1977					X	X	
PL 95-87 Surface Mining Con. & Reclam. Act of 1977		X		X	X	X	X
PL 91-559 Water Bank Act	X		X		X	X	
PL 85-58 Third Supplemental Ap-prop. Act of 1957	X	X	X		X	X	X
PL 79-733 Ag. Market-ing Act of 1946	X	X	X		X	X	X

Table 8-1.--USDA soil and water conservation programs and their authorizing legislation--Continued

Authorizing legislation	Flood plains mgt.	Land reclamation	Water supply	Timber productivity	Watershed protection	Wind erosion	Pasture, range prod.
PL 81-729 Coop. Forest Mgt. Act of 1950	X	X	X	X	X	X	X
PL 70-466 McNary-McSweeny Act, 1928	X	X	X	X	X	X	X
24 Stat. 440 Hatch Act 1887		X	X	X	X	X	X
PL 63-95 Smith-Lever Act, 1914	X	X	X		X	X	X

Table 8-1.--USDA soil and water conservation programs and their authorizing legislation--Continued

Authorizing legislation	Water quality	Waste mgt.	Irrigation water mgt.	Drainage	Cropland productivity	Habitat development	Outdoor recreation
Public Law PL 74-46 Soil Cons. & Dom. Allot. Act	X	X	X	X	X	X	X
PL 83-566 Watershed Protec. & Flood Prev.	X	X	X	X	X	X	X
PL 78-534 Flood Control Act of 1940	X	X	X	X	X	X	X
PL 81-516 Flood Control Act of 1950							
PL 87-703 Food & Agriculture Act of 1962	X	X	X	X	X	X	X
PL 84-1021 Amend. Soil Cons. Dom. Allot. Act.	X	X	X		X	X	
PL 92-419 Rural Development Act of 1972	X	X	X	X	X	X	X
PL 95-217 Clean Water Act of 1977	X	X	X				
PL 95-87 Surface Mining Con. & Reclam. Act of 1977	X	X			X	X	X
PL 91-559 Water Bank Act						X	X
PL 85-58 Third Supplemental Approp. Act of 1957	X	X	X	X	X	X	
PL 79-733 Ag. Marketing Act of 1946	X	X	X	X	X		X

Table 8-1.--USDA soil and water conservation programs and their authorizing legislation--Continued

Authorizing legislation	Water quality	Waste mgt.	Irrigation water mgt.	Drainage	Cropland productivity	Habitat development	Outdoor recreation
PL 81-729 Coop. Forest Mgt. Act of 1950	X	X				X	X
PL 70-466 McNary-McSweeny Act of 1928	X	X				X	X
24 Stat. 440 Hatch Act 1887	X	X	X	X	X		X
PL 63-95 Smith-Lever Act. 1914	X	X	X	X	X		

Chapter 9 - State Laws

Introduction

This chapter does not present a comprehensive list of state laws dealing with conservation of soil, water, and related natural resources. Instead, the data from a brief survey were used to show the number of such laws and how they have proliferated in recent years. The survey was not an exhaustive search of state laws, but it pinpointed the laws of most concern to managers of natural resource programs.

This chapter also discusses some representative state laws on soil and water conservation to illustrate the legislative approaches used by the states.

Soil Conservation Districts

In 1937, the President sent a model state act for creating soil conservation districts to each state governor. In time, all the states enacted legislation based on this model. These state laws are enabling acts which provide a mechanism for forming soil conservation districts (SCD's). The exact name given to these districts varies somewhat. But they were all formed to conserve soil, water, and related resources. They are governed by a locally elected or appointed board of officials generally called directors or supervisors. The general pattern across the Nation is that SCD boundaries tend to coincide with county boundaries. There are frequent exceptions to this rule, however, including some SCD's which cover more than one county and other SCD's which cover only part of one county.

Tables 9-1 through 9-4 display the major provisions of conservation district laws enacted by states and possessions.

All SCD's have entered into memoranda of understanding with the Secretary of Agriculture in which each agrees to develop a program for conservation that outlines priorities. The Secretary agrees to assist the SCD's to help them carry out their programs. An SCD may also enter into supplemental memoranda of understanding with individual USDA agencies.

The SCD's form a nationwide system; only a few, small, and scattered areas do not have them. The system is based on relatively uniform state laws, local initiative and governance, and cooperation with federal agencies. It provides a mechanism for delivering much of the conservation assistance authorized under the federal laws listed in chapter 8. In addition, many of the federal conservation assistance programs that are less formally tied to SCD's use them as an important part of their delivery systems.

Sediment and Erosion Control Laws

In 1973, the Council of State Governments published a Model State Act for Soil Erosion and Sediment Control. This model was prepared by a task force after the March 1972 meeting of the Workshop on Soil Erosion sponsored by the National Association of Conservation Districts (NACD). The Model Act is an attempt to set down the basic requirements for an effective state soil erosion and sediment control law. It is designed to amend state soil

Table 9-1

MAJOR PROVISIONS OF CONSERVATION DISTRICTS LAWS ENACTED BY STATES AND POSSESSIONS IN EFFECT AS OF JANUARY 1, 1975

State Conservation Districts Laws 1/
Purposes and Policies of Laws
State Agency Administration
Published by the National Association of Conservation Districts with assistance by the
Office of the General Counsel and the Soil Conservation Service of the U. S. Department of Agriculture

(A reference to the particular law will be essential
for a complete explanation of provisions)

STATES AND POSSESSIONS	STATEMENT OF PURPOSE AND POLICY OF LAW					STATE SOIL CONSERVATION COMMITTEE (BOARD OR COMMISSION): NAME		POSITION WITHIN STATE GOVERNMENT					MEMBERSHIP AND COMPENSATION								
	Legislative determination	Broadened scope	Declaration of policy	Broadened program	Extended to include renewable natural resources	State soil conservation committee	Name changed to reflect broadened scope of law	Independent agency	Responsible to, or associated with, State Department of Agriculture or State University	State Department of Conservation or Natural Resources	State Environmental Department	Other state department or agency	Total number	Farmers or ranchers	Officers of other state agencies	Urban or other non-farmer representation required	Appointed	Elected	Advisory	District supervisors	Compensation authorized in addition to expenses
Alabama	X	X	X	X			2/	X					9		3		6			6	
Alaska			X			X 3/				3 3/			3	3			3				
Arizona			X			4/						5/	4/								
Arkansas	X	X	X	X			2/					6/	7				7				
California	X	X	X	X			7/			X			7	1		2	7			4	
Colorado			X			X				X			9				1	8	4	8	
Connecticut						8/					8/		8/								
Delaware			X	X		9/				X			7								
Florida	X	X	X	X			2/		X				5	5			5				
Georgia	X		X				2/	X					5				5		13 10/	5	
Hawaii						11/				X											
Idaho	X		X			X						12/	5				5		3 16/		
Illinois			X	X	X	13/			X										8 16/		
Indiana	X	X	X	X			2/			X			7	4	3		7		14/		X
Iowa		X	X			X		X					13	6	5	2			2 16/		X
Kansas	X	X	X	X			15/	X					9		2		2	5	2		X
Kentucky		X	X	X	X		15/				X		9				X		5	9	
Louisiana	X	X	X	X			2/	X					7	5	2			5			X
Maine			X	X			2/	X					11		5		2	4	16/	4	
Maryland	X		X	X		X			X				11		4		4		2	4	
Massachusetts		X			X		17/				X		7		3		4		3		
Michigan			X						X				7	4	3		4		16/	4	X
Minnesota	X		X	X			2/			X			9		4		5			5	X
Mississippi	X	X	X	X			2/	X					11		6			5	2	5	X
Missouri							23/	X					5	3	2		5				
Montana	X		X	X						X											
Nebraska		X	X	X			18/	X					15			1	3	12	13	12	X
Nevada	X	X	X	X	X		2/			X			9		2		7				
New Hampshire		X	X	X		X		X					9		4		5		14/ 16/	5	
New Jersey			X	X		X			X				11		4		2 16/	6		6	
New Mexico	X	X	X	X	X		2/	X					12				7		5	6	

STATES AND POSSESSIONS	STATE SOIL CONSERVATION COMMITTEE (BOARD OR COMMISSION): AUTHORIZED ACTIVITIES																		
	Assist districts in preparing and carrying out programs	Facilitate interchange between districts	Review agreements or agreement forms for district use	Review and coordinate programs of districts	Request state appropriations for state agency and districts	Receive and distribute funds to districts	Enlist cooperation of state, federal, and other agencies	Facilitate arrangements for districts to serve as local operating agency	Make information available to public	Cooperate in coordination of other agencies' plans affecting renewable natural resources	Assist in resolving conflicts of programs of districts and other agencies	Make studies and analyses of district programs	Carry out policies of state at state level for conservation of renewable natural resources, and represent state in matters affecting such resources	Assist districts in obtaining legal assistance	Require annual reports by districts	Set up uniform accounting and auditing procedures for districts	Carry out same activities as districts	Approve Public Law 566 or other federal projects for state
Alabama	X			X			X		X						X			
Alaska																	X 3/	
Arizona	X	X	X	X	X	X	X	X	X									
Arkansas	X	X		X	X	X	X	X	X	X	X	X	X		X	X		X
California	X	X		X	X	X	X		X	X		X	X	X	X			X
Colorado		X		X	X	X	X				X			X	X	X		
Connecticut	X			X	X	X	X										X 8/	X
Delaware	X	X		X	X	X	X					X		X			X	
Florida	X	X	X	X		X	X		X			X			X			
Georgia	X	X		X	X	X	X		X					X				
Hawaii	X	X		X	X		X		X									
Idaho	X	X		X	X	X	X		X									
Illinois	X	X	X	X	X	X	X		X									
Indiana	X	X		X	X	X	X		X						X			
Iowa	X	X		X	X	X	X		X									
Kansas	X	X		X		X	X	X	X									
Kentucky							X								X			
Louisiana	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		
Maine	X	X		X	X	X	X		X								X	
Maryland	X	X		X		X	X		X									
Massachusetts				X		X	X		X									
Michigan	X	X		X			X		X									
Minnesota	X	X		X		X	X		X						X			
Mississippi	X	X		X		X	X		X			X						
Missouri	X				X	X	X					X						
Montana	X	X		X			X		X									
Nebraska	X	X		X			X		X	X	X	X	X					
Nevada	X	X		X			X	X	X	X	X	X	X					
New Hampshire	X	X		X	X	X	X		X	X		X						
New Jersey	X			X		X	X		X									
New Mexico	X	X		X		X	X		X	X								

New York			X	X			2/		X				5	2		1	5		5		X		X		X			X		X								
North Carolina	X	X	X	X			2/					24/	7				1		16/	6	X	X	X		X		X	X		X								X
North Dakota			X	X		X		X					7				2	5	6		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
Ohio							2/			X			7	2	2		4		1			X	X		X	X	X	X		X	X					X		
Oklahoma	X	X	X	X	X		15/	X					5	3			5			5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Oregon		X	X	X	X		2/	X					7	5		2	7		3 16/		X	X	X	X	X	X	X	X		X		X	X			X		
Pennsylvania			X	X			15/				X		9	4	3	2	6		2		X	X	X		X		X	X		X						X	X	X
Rhode Island	X	X	X	X	X		15/			X			7		3 19/		1		9	3		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
South Carolina	X	X	X	X			21/	X					5				5		9	5		X	X		X	X	X	X		X	X		X	X				
South Dakota		X	X		X		15/		X				9	4	1	4	8		5 16/			X	X		X	X	X	X		X	X	X		X				
Tennessee						X		X					10	3	3					4		X	X		X			X		X								X
Texas	X	X	X				2/						5		4			5	5		X	X			X		X	X		X								
Utah	X	X	X	X		X			X				10		4		6			6		X	X		X			X		X							X	
Vermont			X	X	X		22/				X		7	4	3		4		4 16/	4	X	X	X		X	X	X	X		X		X				X		
Virginia	X	X	X	X	X		2/	X					11-12	6	4		7		16/			X	X		X	X	X	X		X	X	X		X				X
Washington	X	X	X	X	X		15/	X					7	3	2		2	3		3		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	
West Virginia	X	X	X	X		X		X					7		4		3		16/			X	X		X		X	X		X								
Wisconsin		X	X	X	X		20/		X				8	4			4	4	5 16/	4	X	X	X		X	X	X	X		X	X	X	X		X	X		X
Wyoming		X	X	X	X		15/	X	X				10		5			5	16/	5		X	X		X	X	X	X	X	X		X		X	X	X	X	
Puerto Rico			X			X			X				9		4		5		16/	5	X	X	X		X		X	X		X								
Virgin Islands		X	X	X	X																																	

1/ Includes conservation districts, soil and water conservation districts, conservation districts, etc.

2/ State Soil and Water Conservation Commission (committee, board, or council).

3/ Powers are in the Commissioner of Natural Resources; Soil Conservation Board advises the Commissioner and governs the district, which includes the entire state.

4/ State Natural Resource Conservation Commission.

5/ State Land Department.

6/ Division of Soil and Water Resources, Department of Commerce.

7/ State Resource Conservation Commission establishes policies for Division of Resource Conservation, the administering agency.

8/ Powers are in the Commissioner of Environmental Protection who appoints a council and establishes soil and water districts and boards.

9/ Responsibility in the Division of Soil and Water Conservation, Department of Natural Resources and Environmental Control.

10/ Ex officio.

11/ Department of Land and Natural Resources.

12/ Department of Lands.

13/ Department of Agriculture exercises powers.

14/ Governor may appoint advisory members.

15/ State Conservation Commission or committee.

16/ Committee may invite Secretary of Agriculture to appoint a member.

17/ Committee for Conservation of Soil, Water, and Related Resources.

18/ Natural Resources Commission.

19/ Includes two members of legislature.

20/ Board of Soil and Water Conservation Districts.

21/ State Land Resources Conservation Commission.

22/ Natural Resources Conservation Council.

23/ State Soil and Water Districts Commission.

24/ Department of Natural and Economic Resources.

Table 9-2

MAJOR PROVISIONS OF CONSERVATION DISTRICTS LAWS ENACTED BY STATES AND POSSESSIONS
IN EFFECT AS OF JANUARY 1, 1975

Conservation District Organization
Published by the National Association of Conservation Districts with assistance by the
Office of the General Counsel and the Soil Conservation Service of the U. S. Department of Agriculture

(A reference to the particular law will be essential
for a complete explanation of provisions)

STATES AND POSSESSIONS	DISTRICT IDENTIFICATION				DISTRICT DEFINED AS			POWER TO CREATE DISTRICTS									DISTRICT BOUNDARIES CHANGES IN BOUNDARIES AND NAME							SUB-AREAS		DISCON-TINUANCE	
	Soil conservation district	Soil and water conservation district	Conservation district	Other	Governmental subdivision of state	Public Body, Corporate and Politic	Other	Vested in state committee (board or commission)	Petition by: Owners	Owners and non-owner operators (occupiers)	Organized by county governing body	Referendum on creation of district	Vote in referendum by: Owners	Owners and non-owner operators (occupiers)	Electors	% vote necessary to permit creation of district	Established by state law	Coterminous with county lines	Provisions for: Adding territory	Changing boundaries	Including urban areas	Changes simplified	Changing name	Subdistricts authorized	Project areas authorized	By petition and referendum	% vote making discontinuance mandatory
Alabama		X			X	X		X	X			X	X			67			X	X	X		X	X		X	50
Alaska	X																X							X			
Arizona				11/		X		X	X			X	X			65 2/			X	X		X				X	65
Arkansas	X		X		X	X		X	X			X	X			67			X	X			X		X	X	51
California				1/					X		X	X			X	51			X	X		X	X			X	51
Colorado	X					X		X	X			X	X 10/			51			X	X			X		X	X	51
Connecticut		X						3/																			
Delaware		X			X												X	X									
Florida		X			X	X		X	X			X	X			51			X	X			X	X		X	67
Georgia		X					4/	X									5/		5/	5/		5/	5/			X	51
Hawaii		X			X	X		X		X		X		X		51			X	X						X	51
Idaho	X				X	X		X	X			X			X	51			X	X	X		X			X	51
Illinois		X				X			X			X	X			51			X	X	X		X	X		X	51
Indiana		X			X	X		X	X			X	X			51		X			X		X			X	51
Iowa	X				X	X		X	X			X	X			65			X				X	X		X	65
Kansas			X		X	X		X		X		X		X		51			X							X	51
Kentucky			X		X	X		X	X			X	X			51			X		X			X		X	67
Louisiana		X			X	X		X	X			X	X			51			X	X	X	X	X			X	51
Maine		X				X	4/	X		X		X		X		51			X							X	51
Maryland	X				X	X											X	X 6/		X	X						
Massachusetts			X					X		X									X	X		X				X	
Michigan	X				X	X		X		X		X		X		51			X	X	X		X			X	51

Minnesota		X			X	X		X		X		X		X		51			X	X	X	X	X		X	X	51
Mississippi		X			X	X		X	X			X	X			51			X	X	X					X	51
Missouri		X					7/	X	8/			X		8/		51								X		X	51
Montana			X		X	X		9/		10/		X			X	51			X	X		X	X		X	X	51
Nebraska				11/	X	X		12/									X		X	X	X	X	X		X		
Nevada			X		X	X		X		X		X		X		51			X	X	X	X	X			X	51
New Hampshire			X		X	X											X	X									
New Jersey	X				X	X		X	X			X	X			51 2/			X	X		X				X	51 2/
New Mexico				11/	X	X		X	X			X	X			51			X	X		X		X		X	51
New York		X									X							X									
North Carolina		X			X	X		X		X		X	X			51			X	X	X	X	X	X		X	51
North Dakota	X				X	X		X		10/		X			X	51			X	X						X	51
Ohio		X			X			X	X			X		X		65			X	X	X	X	X		X	X	51
Oklahoma			X		X	X											X			X	X	X	X				
Oregon		X			X	X		X	X			X			X	51			X	X		X	X			X	67
Pennsylvania			X			X					X							X								13/	
Rhode Island			X		X			14/									X	X		X	X					X	19/
South Carolina		X			X	X		X	X			X	X			51			X	X				X		X	51
South Dakota			X		X	X		X	X			X	X			67			X	X			X			X	51
Tennessee	X				X			X	X			X	X			51			X							X	51
Texas		X			X	X		X	X			X	X			67			X	X		X				X	51
Utah	X				X	X		X		X		X		X		51			X	X		X				X	51
Vermont				11/	X	X		X	X			X	X			51			X	X		X	X			X	51
Virginia		X			X	X		X	16/										X	X	X	X	X	X		X	51
Washington			X		X	X		X		X		X			X	51			X	X	X	X	X			X	51
West Virginia	X				X			X	X			X	X			60			X	X			X	X		X	51
Wisconsin		X			X	X					X						X	X								13/	
Wyoming			X		X	X		X	X			X		X		51			X	X	X		X	X		X	51
Puerto Rico	X				X	X		X		X		X		X		51			X							X	51
Virgin Islands			X		X	X											X										15/

1/ Resource conservation district.

2/ Required to represent certain percentage of acreage in district.

3/ Established by Commissioner of Environmental Protection by regulation.

4/ Agency of the state.

5/ Law fixed boundaries as of 7/1/73 with provisions for alteration.

6/ Except Frederick County.

7/ Body corporate.

8/ Or land representatives.

9/ Department of Natural Resources and Conservation.

10/ Must be electors (qualified voters).

11/ Natural resources district.

12/ Specific number of districts and boundaries determined by state commission, not less than 16 nor more than 28.

13/ Action of county board.

14/ Committee determines whether district shall function.

15/ Legislature may consider every five years.

16/ Petition may be by voters, or by governing body of a district, county, or city

Table 9-3

MAJOR PROVISIONS OF CONSERVATION DISTRICTS LAWS ENACTED BY STATES AND POSSESSIONS
IN EFFECT AS OF JANUARY 1, 1977

Conservation District Governance
Published by the National Association of Conservation Districts with assistance by the
Office of the General Counsel and the Soil Conservation Service of the U. S. Department of Agriculture

(A reference to the particular law will be essential
for a complete explanation of provisions)

STATES AND POSSESSIONS	GOVERNING BODY MEMBER KNOWN AS:				SELECTION AND QUALIFICATION OF GOVERNING BODY MEMBERS								VACANCIES FILLED		ELIGIBILITY TO NOMINATE AND VOTE				TERM OF OFFICE					GOVERNING BODY FUNCTIONS				
	Supervisors	Directors	Commissioners	Other	Appointed (number)	Elected at: General election (number)	Special election (number)	Representative of Urban or non-farm interests (number)	Representative of designated areas (number)	Land owners (number)	Electors (number)	Land Occupiers (number)	As retiring member was selected	By appointment	Owners	Owners and non-owner operators	Occupiers	Electors	Appointed members (years)	Elected members (years)	Terms expire at different times	Removal for: Misfeasance, malfeasance, nonfeasance	Failure to attend meetings	Governing body to organize annually and elect chairman from among members	May call on state commissioner or attorney general for legal services	Governing body to provide annual audit	Governing body may appoint advisory committees for coordination with other agencies	Governing body may receive compensation in addition to expenses
Alabama	X				5 1/				5	X				X					3		X	X				X		
Alaska	2/				-		5					5					X											
Arizona	X				2 3/		3				5			X				X	2	6	X	X	X	X				X
Arkansas		X			2		3			2	3			X				X 4/	3	3	X	X			X	X		
California		X				5				5 5/				X				X		4	X			X	6/	X	X	
Colorado	X				2		3			3				X				X 4/	2	3	X				X	X		
Connecticut	X 7/																											
Delaware	X				2		4	8/						X					3	4		X		X				
Florida	X					5					5			X				X		4				X		X		
Georgia	X				9/		10/						X					X	2	4	X	X				X		
Hawaii		X			2		3						X				X		3	3	X							
Idaho	X						22/			5/7				X				X		4	X	X				X		
Illinois		X					22/			5				X		X				2	X					X	X	X
Indiana	X				2		3						X				X			3	X	X				X		
Iowa			X				5				5		X					X		6	X	X			X	17/		
Kansas	X				2		3				5	5		X			X		3	3	X	X				X		
Kentucky	X					7		3						X				X		4	X	X						X
Louisiana	X				2		3			5	5	5		X				X	3	3	X	X		X		X		X
Maine	X				2		3						X				X		3	3	X				X			X
Maryland	X				5									X					4			X	X	X		X		X
Massachusetts	X						5					5		X			X			5	X					X		X
Michigan		X					5							X		X	X			3	X			X	X	X		
Minnesota	X					5					5			X				X		6	X	X			6/	X		X
Mississippi			X		2		3			5 22/				X	X				3	3	X			X		X		

Missouri	X			21/		4					4 11/		X		X 11/				4	X					X		
Montana	X			2		5	2						X				X	3	3		X		X	X	X		
Nebraska		X			5-21 12/								X				X		4	X	X				X		
Nevada	X			1-2		5	1-2			5		X			X			2	4	X	X	X	X		X		
New Hampshire	X			5 3/							5		X					3		X					X		
New Jersey	X			3-5					3-5				X					13/									X
New Mexico	X			2		5		4	4				X	X				1	3				X		X		
New York		X		5			1					X						14/		X	X	X			X		X
North Carolina	X			2 15/	3								X				X	4	4	X	X			X	X		X
North Dakota	X			2 16/	3						3		X				X	1	6	X	X			X			
Ohio	X					5						X	X		X				3	X	X		X		X		
Oklahoma		X		2		3				3			X				X	2	3	X	X		X	X	X	X	
Oregon		X			5-7			3-5	3-5		1-2		X				X		4	X	X	X		X	X		
Pennsylvania		X		7			2-4					X						4 23/		X		X	X		X		
Rhode Island		X		5							5	X				X		3	3	X			X	X	X	X	
South Carolina			X	2		3				3			X				X	3	3		X			X	X		
South Dakota	X				5		1		1		3		X				X		4	X	X		X	X	X		X
Tennessee	X			2		3						X		X				3	3	X	X			X	X		
Texas		X				5		5	5				X	X					5	X					17/		X
Utah	X			2		3							X			X		3	3	X	X						X
Vermont	X					5				5			X	X					5	X	X		X	X	X	X	X
Virginia		X		2	3 18/					3			X				X	3	3	X	X				X	X	
Washington	X			2		3			3				X				X	3	3	X	X			X	X	X	
West Virginia	X			2		19/			2				X	X				3	3	X	X				X		X
Wisconsin	X			20/								X						2							X		X
Wyoming	X				5		1		3	1			X		X		X		4	X	X			X			
Puerto Rico	X			2		3					5		X			X		2	2	X			X				
Virgin Islands	X			11			2	9			6		X					3		X		X					

1/ One member to represent each county, but not less than five.

2/ Governing body of subdistricts created by Commissioner of Natural Resources.

3/ Additional advisory members may be appointed.

4/ Must also be landowner.

5/ Or agent of landowner who resides in the district.

6/ May call on county attorney.

7/ The Commissioner of Environmental Protection is authorized to issue regulations establishing procedures for establishing districts and selection of supervisors.

8/ In two districts, four elected must be farmers; in third district, two elected must be farmers, two must be nonfarmers.

9/ One for each county in district, except two appointed for single county districts.

10/ One elected for each county in district, but not less than three for each district.

11/ Land representative resident tax paying citizen.

12/ Number determined by state commission.

13/ Serve at pleasure of state committee.

14/ Two serve one year, three serve three years.

15/ One additional supervisor may be appointed in districts composed of four or more counties.

16/ The elected supervisors may appoint two supervisors.

17/ Biennially.

18/ Increased if district contains more than one county or city.

19/ One from each county or portion of a county in district, plus one for coun or portion thereof having over 800 cooperators.

20/ County Agriculture and Extension Education Committee and not more than two additional persons appointed by the County Board of Supervisors.

21/ One ex officio member, the county agricultural extension agent.

22/ Or occupiers, farmers, operators.

23/ Except one county commissioner who serves one year.

Table 9-4

MAJOR PROVISIONS OF CONSERVATION DISTRICTS LAWS ENACTED BY STATES AND POSSESSIONS
IN EFFECT AS OF JANUARY 1, 1975

Functions and Powers of Conservation Districts
Published by the National Association of Conservation Districts with assistance by the
Office of the General Counsel and the Soil Conservation Service of the U. S. Department of Agriculture

(A reference to the particular law will be essential
for a complete explanation of provisions)

STATES AND POSSESSIONS	FUNCTIONS								POWERS																									
	Soil conservation	Flood prevention	Drainage	Irrigation	Recreation	Water supply	Pollution control	Sediment prevention	Enter into contracts	Acquire and dispose of property	Provide assistance	Develop district wide plans	Construct and maintain structures	Cooperate with other districts and agencies	Cooperate with districts in other states	Acquire and administer projects	Impose conditions for furnishing assistance	Sue and be sued	Exercise power of eminent domain	Review subdivision or other earth moving plans	Adopt land-use regulations	Carry out state/county erosion and sediment control program	Approve erosion and sediment control plans	Enforcement provisions in erosion and sediment control program	Conduct surveys, investigations and research	Receive money from a county	Receive money from the state	Receive money from the United States	Receive income from property	Levy taxes and assessments	Borrow money	Issue bonds	Receive matching funds	Receive revolving funds
Alabama	X	1/	X	1/				1/	X	X	X	X	X	X		X		X	1/		X				X		X	X	X		1/	1/		
Alaska	X								X		X	X	X	X											X		X	X	X					
Arizona	X	X	X	X	X	X			X	X	X	X		X			X	X							X		X	X	X					
Arkansas	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X	X	X	X		
California	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X							X	X	X	X	X	X	3/	3/	X	2/
Colorado	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X 3/		X				X	X	X	X	X	X	X			
Connecticut 4/	X	X	X	X	X	X		X	X	X	X	X	1	X	X	X	X	X	X						X	X	X	X	X		X			X
Delaware	X	X	X	X	X	X		X	X	X	X	X	X	X			X	X							X	X	X	X	X				X	
Florida	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X			X				X		X	X	X	X	X			
Georgia	X	X	6/	X					X	X	X	X	X	X		X	X		X 3/		X	8/	8/	8/	X		X	X	X					
Hawaii	X							8/	X	X	X	X	X	X			X	X				8/			X		X	X	X					
Idaho	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X							X	X	X	X	X					
Illinois	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X				X		X	X	X	1/	1/	1/		
Indiana	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X							X	X	X	X	X					
Iowa	X	X	1/					X	X	X	X	X	X	X			X	X	1/		5/	X 5/		X	X		X	X	X	1/	1/	1/		
Kansas	X	X	X	X					X	X	X	X	X	X		X	X	X							X	X	X	X	X				X	
Kentucky	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X 3/						X	X	X	X	X	1/	1/	1/		X
Louisiana	X	X	X	X	X			X	X	X	X	X	X	X		X	X	X			X					X	X	X	X					
Maine	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X								X	X	X			X	X		
Maryland	X	X	X	X				X	X	X	X	X	X	X		X	X	X		X	X	8/	8/	8/	X	X	X	X	X		X			
Massachusetts	X	X	X	X	X	X			X	X 7/	X	X	X	X			X	X							X		X	X	X					

Michigan	X	X	6/	6/				X	X	X	X	X	X	X		X	X	X				8/	8/	8/	X	X	X	X	X				
Minnesota	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X	X	X	X	
Mississippi	X	X	X		X			X	X	X	X	X	X	X		X	X	X			X				X	X	X	X	X				
Missouri	X	1/	1/	1/	1/			1/	X		X		1/	X					1/							X	X	X		1/	1/	1/	
Montana	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X			X	8/	8/	8/	X	X	X	X	X	X	X	X	
Nebraska	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X	X	X	X	X
Nevada	X	6/	6/	X					X	X	X	X	X	X	X	X	X	X			X				X	X	X	X	X				
New Hampshire	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X								X	X	X	X	X				
New Jersey	X	X	6/	6/					X	X	X	X	X	X		X	X	X	X		X	8/	8/	8/	X	X	X	X	X		X		
New Mexico	X	X	X	X	X	X		X	X	X	X	X	X	X		X		X	1/	X					X		X	X		X	X	1/	
New York	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X				8/	8/		X	X	X	X	X				
North Carolina	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	1/		X	8/	8/	8/	X	X	X	X	X	1/	1/	1/	
North Dakota	X	X	6/	6/					X	X	X	X	X	X		X	X	X			X				X	X	X	X	X		X		
Ohio	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X				X			X	X	X	X	X				
Oklahoma	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X						X	X	X	X	X		X		
Oregon	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X			X				X	X	X	X	X		X		
Pennsylvania	X	X	X	X					X	X	X	X	X	X			X	X				8/	8/	8/	X	X	X	X	X				
Rhode Island	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X		X		
South Carolina	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	1/	X	X	8/	8/	8/	X	X	X	X	X	1/	1/	1/	
South Dakota	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X			X	8/	8/	8/		X	X	X	X		X		
Tennessee	X	X	X	X					X	X	X	X	X	X		X	X	X			X				X		X	X	X				
Texas	X	6/	6/	X					X	X	X	X	X	X		X	X	X			X						X	X	X		3/		
Utah	X	X	X	X				X	X	X	X	X	X	X		X	X	X			X				X		X	X	X		X		
Vermont	X	X	X						X	X	X	X	X	X		X	X	X			X				X		X	X	X		X		
Virginia	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	1/	X	X	X	X	X	X	X	X	X	X	1/	1/	1/	
Washington	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X		X		
West Virginia	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X		X				X	X	X	X	X				
Wisconsin	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X		X				X	X	X	X	X		X		X
Wyoming	X	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	1/		X				X		X	X	X	1/	1/	1/	
Puerto Rico	X									X	X	X	X	X		X	X								X		X	X	X				
Virgin Islands	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X		X		8/	8/	8/	X		X	X	X				

1/ Power in subdistricts.

2/ Development fund.

3/ Power limited.

4/ Powers are vested in Commissioner of Environmental Protection who has authority to establish districts.

5/ Districts required to establish and enforce soil loss limits.

6/ Based on opinion of State Attorney General.

7/ No real property.

8/ Authority for this activity is contained in a state law other than the district law. Some of these laws were enacted after January 1, 1975.

and water conservation districts laws to strengthen and extend their existing programs.

This model law contains the following principal authorities and requirements.

1. It establishes a comprehensive state soil erosion and sediment control program which applies to different types of land use and soil conditions and identifies areas having critical soil erosion and sediment problems. The model law requires adoption of statewide guidelines including conservation standards for the control of erosion and sediment resulting from land-disturbing activities.

2. It establishes district soil erosion and sediment control programs and conservation standards that are consistent with the state program and guidelines.

3. The model law prohibits certain land-disturbing activities unless they are conducted in accordance with approved soil erosion and sediment control plans. It establishes special requirements for land-disturbing activities that are part of normal agricultural and forestry activities.

4. It uses existing regulatory mechanisms, such as building, grading, and other permits applicable to land-disturbing activities, to enforce requirements in erosion and sediment control plans.

5. The model law contains inspection, monitoring, and reporting requirements and provisions for modifying approved plans by mutual agreement.

6. It includes penalties, injunctions, and other enforcement provisions.

7. It authorizes necessary appropriations.

Fifteen states, the Virgin Islands, and the District of Columbia have enacted erosion and sediment control laws. Many of these include a number of the provisions set out in the Model Act. They are listed below. Laws marked with an asterisk include authority for erosion and sediment control among other authorities.

Georgia	Erosion and Sedimentation Act of 1975 Ga. Code Ann. Secs. 5-2301a--5-2313a (1975 Rev., 1978 Cum. Pocket Part)
Hawaii	Soil Erosion and Sediment Control Hawaii Rev. Stats. Ch. 180-C (1976)
Illinois	Soil and Water Conservation Districts Act S. H. Ill. Code Ann. Ch. 5, Secs. 106--138.100

Iowa	Soil Conservation Districts Law I.C.A. Secs. 467A.1 -- 467A.53 (1971, 1978-79 Cum. Pocket Part)
Maryland	Sediment Control Act Ann. Code Md., Nat. Res., Secs. 8-1101--8-1108 (1974)
Michigan	Soil Erosion and Sedimentation Control Act Mich. Stats. Ann. Secs. 13.1820 (1) -- 13.1820 (17) (1973 Rev. Vol. 9, 1978-79 Cum. Supp.)
Montana	The Natural Streambed and Land Preservation Act of 1975* R.C.M. Secs. 26-1510--26-1523 (1947; 1977 Cum. Supp.)
New Jersey	Soil Erosion and Sediment Control Act N.J.S.A. Sec. 4:24-39--4:24-55 (1978-79 Cum. Pocket Part)
New York	Soil and Water Conservation Law McKinney's Cons. Laws of N.Y., Book 52-B
North Carolina	Sedimentation Pollution Control Act of 1973, Gen. Stats. N.C., Secs. 113A-50-- 113A-66 (1978)
Ohio	Soil and Water Conservation District Law, Page's O.R.C.A. Secs. 1515.01-- 1515.30; 1501.20 (1978)
Pennsylvania	The Clean Streams Law of Pennsylvania* 35 Pa. Stats. Secs. 691.1 <u>et</u> <u>seq</u> (1977)
South Carolina	County Sediment Control Programs Code of Laws of S.C., Secs. 48.13-10-- 48. 13-60 (1976)
South Dakota	Soil Erosion and Sediment Damage Con- trol, S.D. Codified Laws, Secs. 38-8A- 1--38-8A-21 (1977)
Virginia	Erosion and Sediment Control Act Code of Va. Tit. 21, Ch. 1, Secs. 21. 89.1--21.89.15 (1975)
Virgin Islands	Environmental Protection, Shore and Erosion Control, V.I. Code Ann., Tit. 12, Ch. 13, Secs. 531-538 (1977 Cum. Supp.)

Washington, D.C.	Soil Erosion and Sedimentation Control Act of 1977 DC Law No. 2-23, 1977; 24 DC Register No. 4, p. 792

Table 9-5 provides a summary of the principal provisions of the state erosion and sediment control laws.

Zoning

States have enabling acts that delegate land use control to local governments. Historically, states have delegated this authority to cities, where the problems that called zoning into being first arose. It is this delegated authority that provides the legal foundation for the local laws, ordinances, and regulations described in chapter 10.

It has become increasingly apparent that local zoning ordinances, virtually the only land use controls in the United States for over half a century, cannot solve a number of problems of statewide significance. This has led to an increase in state involvement. This does not mean that the states have pulled back local authorities. Instead, they have added their own regulatory system in most cases.

Overview and History of State Laws

Data from an RCA survey reveal the trends in state legislation on natural resources.

(Note: The data gathered by the RCA survey do not represent a comprehensive search of all state laws on natural resources. The data were gathered by people who work in the field of natural resources, rather than by researchers combing through state statutes. The result is a compilation of laws which have a significant effect on natural resource management today, rather than a complete listing of all the past laws, many of which have ceased to be relevant. The figures from the survey should be used to gain an understanding of the level of legislative activity and trends, rather than as an absolutely accurate accounting.)

The following list shows the total number of state laws, regulations, and policies that affect particular resources.

Resources affected	Laws, regulations, and policies
Air	225
Animals	517
Minerals	300
Plants	537
Soil	738
Water	935
Other	144

Table 9A-5.--Summary of principal provisions of state laws providing for erosion and sediment control.
(A reference to the particular law will be essential for complete examination of provisions.)
NOTE: An "x" indicates that the law contains the provision listed. Numbers refer to footnotes.

Provisions	GA	HI	IA	MD	MI	MT	NJ	NY	NC	OH	PA	SC	SD	VA	VI	DC	IL
Type of state law																	
Erosion and sediment control	x	x		x	x		x		x			x	x	x	x	x	
Conservation districts			x					x		x				x			x
Water quality and stream control						x											
Methods of control																	
Approved erosion and sediment control plan required for land disturbance	x			x	x	x	x	x	x		x2	x	26	x	x	x	
Establishment of soil loss limits			x										x				
Permits on basis of an approved plan	x			x			23				x	x	27	x	x	x	
Resources covered																	
Natural resources	14	17		x			14										x
Land	x	x		x			x	25					x	x	x	x	x
Soil			x		x				x	x		x				x	x
Water	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Streams and streambanks						x			x		x						
Exemptions from law																	
Agriculture and horticulture	x		3	x	19				x		4	x		5	x	x	
Mining	x				x				x			x		x			x
Homes or small sites	x	x		6			x					x		x		x	x
Highways or railways	x		7											x			
Minor land disturbances	x	x									4	24		x		x	x
State control agency																	
Participating agencies																	
Soil and water conservation	x		x				x	x		x			x	x	x		
Natural resources	x		x	x	x	x				x							
Other	15	18			20	8	21		29	13	9				28		32
State responsibilities:																	
Develop policies			x								x						
Develop criteria, standards, guidelines	16	x		x	x	x	x		x	x	x		x	x		x	x
Adopt rules and regulations	x				x				x		x						
Review and approve local programs or plans			x	x	x		x		x	x	x		x	x	x	x	
Perform enforcement functions 10/	x			x					x		x		x		x	x	x
Assist local agencies with:																	
Ordinances, regulations, and programs			x	x			x		x							x	x
Enforcement				x	x										x	x	x
Cost sharing			x				22			x						x	x
Approve state and federal agency plans				x										x			x
Adopt program where local agency fails to do so	x	x								x				x			x
Local control program																	
Participating local agencies:																	
Conservation districts	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	31	x
Counties	x	x		x	x	x	x		x		x	x	x	x			
Cities	x			x	x				x		x		x	x			
Towns or townships				x		x		x		x							

Table 9A-5.--Summary of principal provisions of state laws providing for erosion and sediment control (continued)

Provisions	GA	HI	IA	MD	MI	MT	NJ	NY	NC	OH	PA	SC	SD	VA	VI	DC	IL
Conservation district responsibilities																	
Review and approve erosion and sediment control plans	x			x	x	x	x	x	x		x	x	26	x	x		
Establish soil loss limits			x				x										
Assist county or other local agency develop ordinances or regulations		x		x	x												
adopt standards, criteria, guidelines				x		x							x	x			x
Adopt rules and regulations			x			x									x		
Perform enforcement functions 10/			x	x	x	12	x				x	x	x	12	x		x
County, city, town or township responsibilities																	
Adopt programs									x		x	x	x	x			
Review and approve plans				11	x				x		x						
Adopt ordinances	x	x		x	x				x								
Issue permits on basis of an approved plan	x			x			23				x			x		x	
Perform enforcement functions 10/	x			x	x		x		x		x	x	x	x		x	
Issue rules and regulations				x					x			x					

1. Authorities contained in laws and regulations
2. Acceptable plan required at site of activity
3. Erosion control practices may not be required on lands used for such purposes only
4. Exempted from permit requirements only
5. Except as to grading, excavating, or filling
6. Except in Calvert County
7. Within city limits
8. Department of Fish and Game
9. Department of Environmental Resources
10. May include permits, inspection, complaints, violation procedures, fines, other legal actions
11. In municipalities not within a district
12. Special provisions for emergency actions
13. Environmental Protection Agency
14. Air and other resources
15. Division of Environmental Protection of the Department of Natural Resources
16. Established by law
17. And other resources
18. Department of Health
19. Persons engaged in agricultural practices who have agreement with a soil conservation district, will not be subject to any site plans, land use plans, or permits required under the law, but will be subject to enforcement procedures after July 1, 1979.
20. Department of Agriculture
21. Secretary of Agriculture and Commissioner of Environmental protection
22. May assist with grants
23. Certification
24. Emergency repairs
25. Agricultural land as described in the law
26. Required where district determines that an agricultural land-disturbing activity is violating adopted standards
27. Permit issuing authorities must require compliance with district standards
28. Department of Public Works
29. North Carolina Sediment Control Commission
30. D.C. Department of Environmental Services
31. D.C. Agencies engaged in land disturbing activities
32. State Department of Agriculture

Land/water use affected	Laws, regulations, and policies
Community (urban)	568
Cropland	626
Fish/wildlife	732
Flood plains	480
Pasture/range	604
Recreation	655
Waste disposal	412
Wetland	614
Woodland	594
Other	181

It is interesting to note how these state laws evolved over the past 180 years. The earliest law reported in the survey was passed in 1795 and it affected minerals, plants, soil, water, cropland, flood plains, pasture, recreation, and wetlands. A few more laws were passed in 1800. The next law reported was not passed until 1849. After that, states enacted laws on natural resources at a steady but slowly increasing rate. There was a large increase in legislation in 1937, the year the model soil conservation districts act was sent to the states. States continued to pass natural resource laws at an increased rate during the next 4 years. The rate decreased during World War II and into the 1950's. It began to climb again very rapidly in the mid-1960's and into the mid-1970's. In the past few years the rate of enactment has remained at about the same high level.

During the 100-year period from 1795-1894, states passed only 14 laws that affected soils. During the next 40 years, 75 such laws were passed. In 1973 alone, states passed 71 laws affecting soils. Table 9-6 shows the growth of state laws in six selected areas.

Figure 9-1 displays the number of laws affecting soils that states enacted each year. A graph of laws on other resources or land uses would show a very similar pattern. The graph has been smoothed out to simplify visual understanding of the historical trend.

Examples of State Laws

The following are selected examples of state laws dealing with natural resources in which USDA would have an interest or perhaps a direct role. The examples serve to show the scope and approach of the various laws.

Land Use

Hawaii.--The Hawaiian legislature passed a land use law in 1961 which created a state land use commission and required the commission to divide the state into four types of districts:

1. Urban districts. County zoning regulations can determine land use in these districts. State and county approval is required for most urban development.

Table 9-6.--State natural resource laws enacted during selected time periods (figures are not cumulative)

Resource or land use affected	1795-1844 ((50 years)	1845-1894 (50 years)	1895-1934 (40 years)	1935-1954 (20 years)	1955-1964 (10 years)	1965-1971 (7 years)	1972-1978 (7 years)
Soil------------------	2	12	75	120	66	166	269
Water-----------------	4	13	101	152	97	211	366
Fish/wildlife---------	2	12	68	133	89	153	274
Flood plains----------	3	7	37	86	55	109	182
Waste disposal--------	0	6	16	75	38	102	175
Wetlands--------------	4	13	62	110	70	128	227

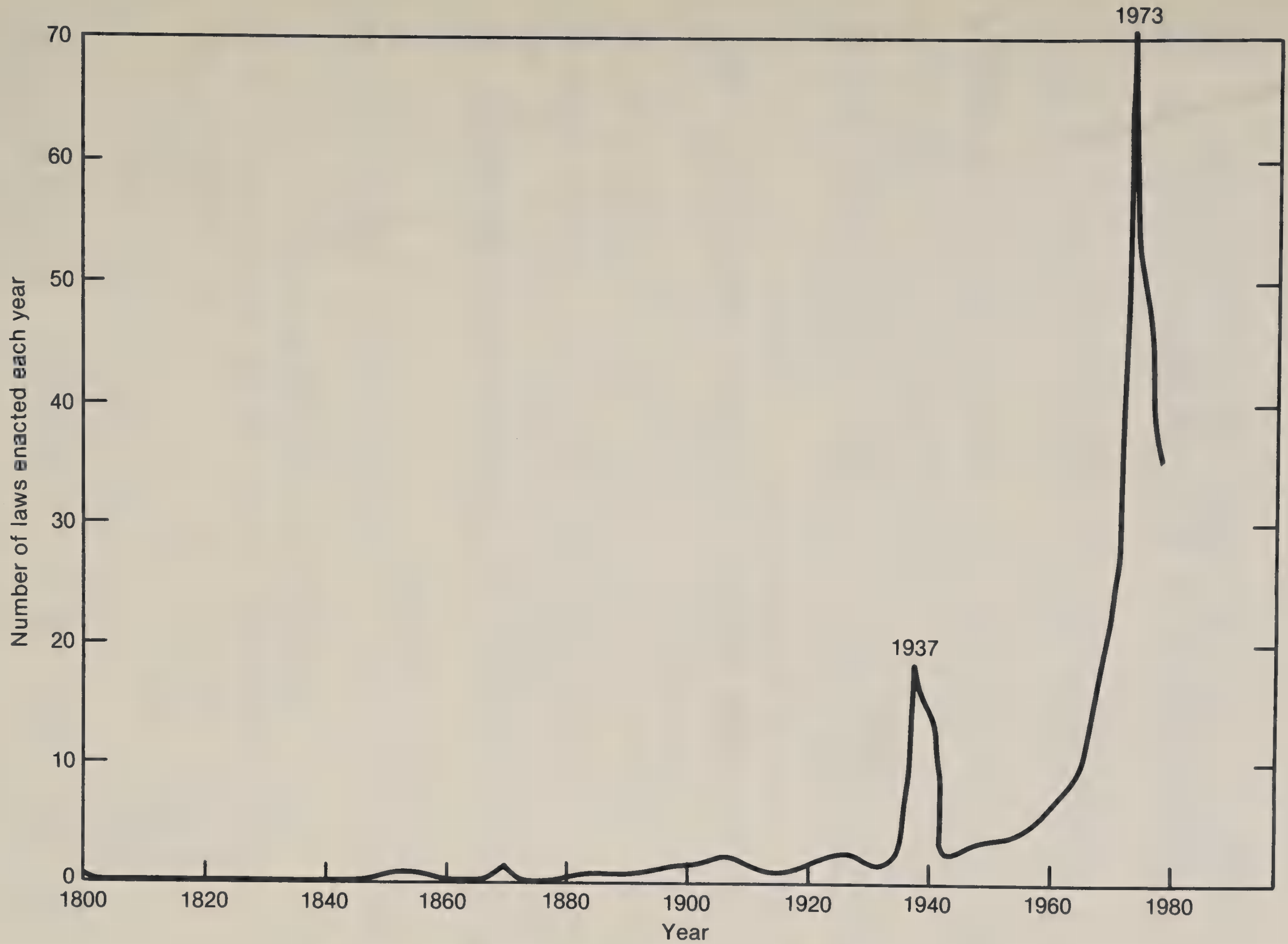

Figure 9-1.--Number of state laws enacted each year that affect soils (curve smoothed).

2. Rural districts. These districts include low density residential development. The state commission regulates land use.

3. Agricultural districts. Uses in agricultural districts are regulated by the land use commission. If the county planning commission and the land use commission approve, special use permits may be issued.

4. Conservation districts. The Hawaii Department of Land and Natural Resources has sole jurisdiction over the use of land in these districts.

Vermont.--In 1970, Vermont enacted a law which created an environmental board and assigned it two areas of responsibility. One of its functions is to issue development and subdivision permits through seven district commissions. The other is to adopt a statewide comprehensive land use plan. The environmental board is a nine-member body appointed by the governor as an independent regulatory agency located within the Vermont Agency of Environmental Conservation.

The following types of developments require a permit:

a. commercial or industrial developments which exceed 10 acres,

b. housing projects with 10 or more units,

c. developments by municipal and state agencies, and

d. any development above the elevation of 2,500 feet regardless of its size or the number of units.

Prior to issuing a permit, the district commission must consider the effects on:

a. water and air pollution,

b. water supplies,

c. erosion and water absorption by the soil,

d. natural beauty, historic sites, and rare natural areas,

e. the state land use plan and local or regional plans, and

f. community services such as transportation and schools.

The law requires that the board adopt three state plans: (1) an interim plan which lists current land uses, (2) a capability plan, and (3) a state land use plan.

Colorado.--In response to rapidly increasing pressure on its land resources, Colorado passed three laws in 1971 which are collectively called the Colorado Land Use Act. The Act requires the land use commission to develop model subdivision regulations for counties. The commission is responsible for developing a system for monitoring growth and change that can be used at all levels of government and a means of evaluating the impact of a proposed development. It is also required to develop a system for identifying the environmental effects caused by development and standards for flood plain control.

The governor can restrain development based on a recommendation by the commission. All counties must create planning commissions and develop subdivision regulations according to the state's minimum standards. The state provides some funds to carry out planning in areas of critical need. The commission can adopt regulations if the county does not.

Wetlands Protection

Massachusetts.--Massachusetts protects its coastal wetlands from harmful development with the Coastal Wetlands Act of 1965. The Hatch Act of 1965 and the Inland Wetlands Act of 1968 protect inland wetlands.

Under the Coastal Wetlands Act, the Massachusetts Department of Natural Resources issues protective orders for individual tracts of coastal wetlands. The Department first maps such areas and determines the need for protection. Then a public hearing is held before the final protective order is recorded. Under the protective order, uses such as recreation and hunting are allowed. More intensive uses and modifications are allowed only by special permit.

The Hatch Act covers inland wetlands and requires landowners to obtain a permit when they wish to develop or modify a wetland area. Agricultural lands are excluded. Under the Hatch Act, the Department of Natural Resources may impose conditions on the permit but they cannot prohibit development.

The Inland Wetlands Act provides for protective orders on inland wetlands similar to those on coastal wetlands. However, this act is weaker than the Coastal Wetlands Act for three reasons:

1. The definition of inland wetlands is narrow.

2. It does not provide for regulation of land contiguous to the wetland.

3. The landowner may "veto" the protective order by sending a letter stating his objections.

Shoreland Protection

Wisconsin.--Wisconsin's Water Resources Act of 1966 requires counties to enact regulations to protect all shorelands in unincorporated areas. It covers land within 1,000 feet of a lake, pond, or flowage and within 300

feet of a stream or the landward side of a flood plain. The county ordinances must meet minimum standards set by the state. If a county does not develop its ordinance, then the state can adopt one for it.

The Water Resources Act also requires county flood plain zoning. However, the emphasis is on minimizing flood damage, whereas the emphasis in shoreland zoning is to preserve the quality of the waters and adjoining land. The flood plain zoning applies to cities and villages.

The Wisconsin Division of Environmental Protection has established standards and criteria for shoreland zoning in a model ordinance which created three shoreland districts:

1. The conservancy district is generally limited to specific uses such as forestry, hunting, and fishing.

2. The residential-recreational district allows all the same uses as the conservancy district, plus single family homes and, by special exception, certain commercial enterprises such as hotels, campgrounds, and marinas.

3. The general purpose district is a catchall which includes all shorelands not in the other districts. Most uses are permitted unless subsequent detailed planning shows that a specific use should be restricted.

Although the state has authority to compel a county to adopt shoreland ordinances, it has no authority to enforce them. This is left strictly to the individual counties.

Soil and Water Conservation Districts

Illinois.--The 1971 amendment to the Soil and Water Conservation District Law of Illinois requires that anyone petitioning municipalities or county agencies to obtain a variance to prevailing ordinances or to subdivide vacant or agricultural lands must furnish a copy of the proposal to the local soil and water conservation district (SWCD). The SWCD then has 30 days in which to submit a written opinion concerning the petition to the county or municipality. In addition, the SWCD is to make all natural resource information available to counties or municipalities when they promulgate zoning ordinances or variances.

Sediment Control

Maryland.--In 1970, Maryland was the first state to enact a law requiring all counties to adopt erosion and sediment control ordinances. The law provides that the Maryland Department of Natural Resources will establish criteria and procedures for counties and local soil conservation districts to use in implementing soil and shore erosion programs. Grading and sediment control plans must be approved by the local soil conservation district. The county agency responsible for onsite inspection and enforcement of erosion control measures must make a report to the local soil conservation district.

Reclamation of Mined Land

West Virginia.--The West Virginia Department of Natural Resources' "State Mining Reclamation Regulations" (1971) contain provisions on drainage and revegetation. A drainage plan must show how surface water will be removed from a mining site and where it will be discharged. The regulation requires suitable treatment of surface water, the use of ponds to control sediment, and reasonable measures to prevent surface water from entering a mining pit. Water discharged from a permit area must be monitored and reports submitted to the state. The revegetation section requires a planting plan and it sets forth standards for revegetating mined areas so they can be stabilized as quickly as possible.

Preservation of Agricultural Land

Wisconsin.--Chapter 440, Laws of 1977 of the State of Wisconsin, (June 6, 1978), requires that an agricultural impact statement be prepared for a public project in the state if the project involves the actual or potential exercise of the powers of eminent domain and if any interest in more than 5 acres of a farm operation may be taken. The impact statement is prepared by the Department of Agriculture, Trade, and Consumer Protection.

The agency that may exercise the powers of eminent domain must notify the Department of any such project, supply necessary information, and reimburse it for the costs of preparing the impact statement.

The impact statement describes all land that may be lost to agricultural production and all other land that may have its productive capacity reduced. The statement must be prepared in 60 days. The agency may not negotiate with the owner until 30 days after the impact statement is published. The published statement is distributed to:

1. The Governor's Office
2. The State Senate and Assembly Committees on Agriculture and Transportation
3. All local units of government
4. News media
5. Public libraries
6. Other groups that have expressed interest
7. The agency conducting the project

Chapter 10 - Local Laws, Ordinances, and Regulations

Less is known about local laws, ordinances, and regulations pertaining to natural resources than is known about federal and state laws. It appears that no one has even begun to compile what must be thousands of such local laws. Several officials in charge of local planning activities in state planning offices were consulted. None of them had a compilation of local laws in existence in their state, nor did they have any clear idea of the scope and coverage of such laws.

The survey on state laws also collected data on local (multicounty, county, and municipal) laws. However, because the survey was conducted at the state level, the data on local laws is incomplete. Consequently, this chapter is limited to a broad discussion of trends and some specific examples of existing local legislation.

Local zoning began in the early 1900's. A Supreme Court decision in 1929 legitimized the power and rights of governments to enact and enforce zoning. During the 1950's, local governments began to expand the scope of their ordinances to cover natural resources. Many of these ordinances focused on the suitability of the resources to support development.

Local jurisdictions, particularly counties and municipalities, began to show considerable interest in enacting soil, water, and related resource laws in the late 1960's and early 1970's. This interest coincided with a widespread increase in the public's concern for the environment. Although there appears to be no comprehensive compilation of such laws, dozens of examples are available. Most of these local laws deal with subdivision controls, erosion control, sediment reduction, and restrictions on the use of certain types of land.

Trends

It appears that the rapid increase in local ordinances governing soil, water, and related resources began to level off after 1973. Discussions with state planning officials in Colorado, Illinois, Louisiana, Maine, Pennsylvania, and Tennessee confirm this observation. The reasons for this are not known, but the following factors may have contributed to the decline in new ordinances:

1. During the past 15 years, states have enacted natural resource laws at a greatly accelerated rate. (See chapter 9.) Many of these state laws have:

    a. made existing county or municipal laws outdated or superfluous, and

    b. made it unnecessary for local entities lacking such laws to enact their own.

2. A disadvantage of local resource laws is the wide variation that can occur in different jurisdictions in a relatively small geographic area. This leads to inequities in development that can give one community a comparative economic advantage over another. This situation may have contributed to the tendency for state laws to take over. State laws provide uniformity over broader geographic areas. Of course, some inequities may still exist across state boundaries.

3. There are no reliable data on the coverage of local ordinances. How many counties have their own ordinances dealing with soil erosion or other resource problems is not known. However, in spite of the great increase in these ordinances in the late 1960's and early 1970's, it appears that the coverage is fairly spotty nationwide. It is common for one county to have a fairly comprehensive ordinance while its neighbor has none. This fact may also have encouraged the states to act to achieve conservation objectives throughout their jurisdictions.

4. In some cases, local ordinances may not be implemented and enforced as effectively as state laws. This is true even though the onsite enforcers are likely to be the same people whether the law is statewide or local. However, exceptions to the law or actual failure to enforce the law may be less likely when the impetus comes from the state.

5. The peak of public interest in such matters may have passed. Such national events as the slowdown in new housing in the mid-1970's may have served to moderate public interest in supporting conservation legislation which usually tends to restrict land use.

6. Some localities, particularly in the Northeast, were hit hard by the 1973 recession and by the movement of many businesses to the "Sunbelt." This may have caused some local governments to become more flexible about land use in order to maintain and attract industry.

Examples

What follows is a sampling rather than a comprehensive compilation of the local laws, ordinances, and regulations now in effect. It shows the range of such laws and the general approach being taken.

1. County Zoning Ordinance--Buffalo County, Wisconsin. The county zoning ordinance establishes "overlay districts" that are based on soil characteristics. These include wet soils overlay districts, steep soils overlay districts, and flood plain districts.

The establishment of wet soils and steep soils overlay districts focuses attention on soil problems. Developers must consider these problems when they prepare their plans. When developers take adequate steps to compensate for soil limitations, their requests for permits can be granted. The ordinance limits the use of flood plains to those activities that will not hamper flood flows.

2. Streambelt Corridors--Town of Marlborough, Connecticut. A town regulation establishes streambelt corridors including flood plains, adjacent

wetlands, associated escarpments, and all land within 150 feet of a stream. Building or construction within this corridor is permitted only by special exception. Filling of the flood plain is prohibited.

3. Sediment and Erosion Control--Steele County, Minnesota. This subdivision regulation includes provisions to control erosion and sediment. When a developer submits a preliminary plan for review, it must include measures to control erosion and sediment. The regulation outlines standards for these measures and the local soil and water conservation district uses them to review a developer's proposals.

4. Storm Water Management--Anne Arundel County, Maryland. This county ordinance, enacted in 1972, stipulates that grading permits for subdivisions and developments are to be denied if the land area lies within the 100-year flood plain. It also requires the developer to use approved storm water management measures to handle any increased runoff caused by changes in soil and surface conditions. Such measures include infiltration beds, dry wells, and retention ponds which meet the requirements and recommendations of the Anne Arundel Soil Conservation District, Department of Water Resources, and Department of Public Works.

5. Waste Disposal--Walworth County, Wisconsin. This sanitation ordinance requires that a permit be obtained to install private water or sewage disposal systems. It prohibits the discharge of any material that will harm or pollute the quality of any water supply. Soils with very severe limitations cannot be used for sewage disposal facilities that rely on soil absorption. Soils with severe limitations and those with over 12 percent slope may not be used for this purpose unless their limitations are overcome. The ordinance lists the soils with severe limitations.

6. Flood Plain Regulation--College Township, Centre County, Pennsylvania. This flood plain regulation is based on the local soil survey. The ordinance identifies alluvial soils to show which lands are in the flood plain conservation district. It also lists permitted uses of land in the flood plain district, conditional uses which must be approved by the zoning board, and prohibited uses. The zoning board must consider the findings and recommendations of the soil and water conservation district in considering appeals of initial determinations.

7. Unique and Fragile Area Protection--Warrenton Dune Soil Conservation District, Warrenton, Oregon. This is one of the very few land use ordinances that have been enacted by the soil conservation districts. It applies only to a unique and fragile dune area within the district. The boundaries of the area are defined. The ordinance lists the required treatment of the area and restrictions on land use. It was passed by a public referendum in April, 1948.

8. Water Course Control--Sonoma County, California. This ordinance on stream obstruction provides for natural drainage and the control of water courses. It regulates the use of water courses and the manner in which they may be altered, obstructed, or encroached upon. Penalties are set down for violations of the ordinance.

9. Agricultural Land Preservation--Calvert County, Maryland. Article 5, Paragraphs 273-283, of the Public Local Laws of Calvert County established the Calvert County Agricultural Land Preservation Program. This action was taken under state enabling legislation which took effect July 1, 1977.

The program is administered by an Agricultural Preservation Advisory Board appointed by the county commissioners. The owner of productive farmland or forest land may petition that his property be placed in an "Agricultural Preservation District."

The Advisory Board approves or denies the petition based on the following criteria:

1. Present land use
2. Percentage of cropland
3. Suitability of the soil
4. Amount of contiguous farmland

If approved, the land remains in the District for at least 8 years, during which farming and forestry must remain the predominant uses and no more than three residential building lots can be subdivided from it.

The owner of land in an Agricultural Preservation District may offer to sell "transferable development rights" (one per acre with certain adjustments). Concurrently with the sale of the owner's development rights an agricultural or forestry covenant is placed on his land.

These development rights may be sold on the open market and applied to other land by a developer provided this other land is in a designated "transfer zone." The rights can be used to decrease the size of the developer's residential lots from 5 acres to not less than 1 acre. The price of the development rights is negotiated between the buyer and seller. This process makes it possible to compensate a landowner for retaining land in agriculture or forestry with no expense to taxpayers.

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(Chapters 8-10)

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PART IV - HISTORY AND TECHNOLOGY

Chapter 11 - Historical and Institutional Setting

Land and Water Use During the Colonial Period

Early European settlers found an almost virgin wilderness of great forests intermixed with small areas of marsh, meadow, swamp, and Indian clearings. These lands provided an incredibly productive habitat for wildlife that was virtually unspoiled by man. The Indian population supported itself primarily by gathering wild plants, hunting, and fishing. Maize was the only crop the Indians cultivated to any extent. The first European settlers adopted this mode of life out of necessity, but they soon added other crops and domestic livestock from seed and animals brought from the Old World. In this setting, virtually the only erosion of the land was geologic.

Clearing the forest for new fields was an arduous task because only simple hand tools were available. The larger trees were girdled and were left standing in the fields for years as oxen pulled plows around them. No fertilizer was used, and each field was planted continuously year after year. Many of the early settlers had no background in farming and no ethic of love for the land. The "Pennsylvania Dutch" who settled in southeastern Pennsylvania were one notable exception to this rule. They had been farmers in the old country and brought with them a genuine love-of-land culture.

Tilling each field continuously inevitably caused the soil to deteriorate. Once the natural fertility of the soil was used, crop yields declined and erosion increased on sloping fields. After several years of this "culture," a field was so depleted and washed that it had to be abandoned. Then more forests with virgin soils were cleared, cropped, and abandoned in a repetitive cycle. Land was cheap. But labor was scarce, except in the colonies where slavery was actively promoted. The cheap land allowed the farm-out-and-move-on philosophy to become firmly entrenched.

By the time of the Revolutionary War, a hundred mile wide area had been opened up from southern Maine to Georgia. Some half to three-quarters of this land was cleared. In the North, about 5 to 15 percent of the land was tilled every year. In the South, 40 to 50 percent was tilled. The population was still small--less than 4 million in the entire Thirteen Colonies.

A succession of colonial wars before the Revolutionary War suppressed the Indian tribes of the Appalachian region and paved the way for later settlement to the west.

The Westward Trek

Little attention was paid to the few prophets who warned of disaster if exploitive farming systems continued. The great West was opening up from New York to Ohio to Tennessee and beyond, and virgin lands beckoned. The fever for acquiring land reached a pitch in the early decades of the nineteenth century. By the late 1830's, hordes of settlers were reaching Ohio and Michigan and moving south to Tennessee and Alabama.

The prairies of the Midwest were discovered. Accustomed to farming woodland soils and judging soils by the trees on them, settlers thought the heavy sodded prairie was sterile and only useful for running livestock. But they soon observed the natural abundance of game and the way stock fattened on the grass, and this illusion passed. Once blacksmiths fashioned plows sturdy enough to break the prairie sod, the great breadbasket known as the Corn Belt came into being.

Because of the abundance of slave labor in the South, cotton and tobacco continued to dominate agriculture in that region. As long as new land was available to replace worn out eroded fields, it was a "successful" system. The plantation system flowered, while the soil washed away under the continuous hoeing for cotton and tobacco. Cotton production increased sixtyfold from 1790 to 1815. There was growing recognition that serious troubles lay ahead, and a few new soil management practices were adopted. But the preponderant farming system continued to exploit the land.

As the central prairies and plains were opened to farming and transportation improved, it became uneconomical to farm much of the cropland in the East, and these lands were abandoned to return to forest. Thus, the economic realities of agriculture allowed land use in the oldest settled areas to become more stabilized.

Once the woodlands of the Midwest were cleared for tillage and the prairie sod was broken, these lands were less able to absorb the heavy rains of spring and summer. As a result, the rivers flooded frequently, destroying fields, homes, and villages. The low-lying river banks, which had once been choice locations for settlement, had to be abandoned. Later generations moved to higher lands nearby.

On much of the prairie lands, water proved to be a serious problem in another way, especially near the Great Lakes. Vast expanses of glaciated soils in that region were covered with shallow water all or much of the year. These marsh prairies produced high crops of waterfowl, but they could not be cultivated without drainage. Drainage development companies and legally constituted drainage districts were formed to solve this problem. Both companies and districts were used widely before the Civil War.

After a lull during the Civil War, homesteading continued to attract swarms of emigrants to the new lands in the West. With better transportation, new farm machinery, and rapidly increasing markets, a boom psychology prevailed among the new wave of settlers. However, new obstacles arose as settlers invaded areas where rainfall was lower and less dependable. On these lands, where the hazards of tillage were great, drought became a major threat. Irrigation became the great hope.

To a considerable degree, the story of American farming in the second half of the nineteenth century can be told by discussing the effects of various homesteading acts and other land laws. The basic Homestead Act, passed in 1862, allowed settlers to acquire 160-acre tracts at little or no cost. A farm of this size in the East, South, or Midwest was a viable economic unit. It also proved satisfactory for some of the available lands just beyond the Mississippi. But west of eastern Minnesota, Nebraska, and

Kansas, where the rainfall dropped to less than 20 inches a year, 160 acres could not support a family.

The efforts of settlers to farm homesteads in the western areas were often pathetic and disastrous. They tried to till too much and damaged the soils. As many homesteaders failed in farming their plots, the land was rapidly consolidated into larger farms. Efforts to correct the law by increasing the size of the homesteads were too late for many thousands of settlers.

In addition to the hundreds of millions of acres of homestead lands, there was a vast acreage for sale under other auspices after the Civil War. The railroads had 125 million acres to sell; the Land Grant College Act of 1862 involved millions more acres; bounty lands were available to war veterans; and much more. The administration of these land gifts and sales led to all sorts of abuses: monopolies, graft, fraud, and considerable speculation. Large areas came under single ownership. This was contrary to a major objective of the laws, which was to create a great class of independent farm owners. By 1910, 37 percent of the farmers were tenants.

In 1877, Congress passed the Desert Land Act, which was intended to correct faults in the earlier laws as they applied to the more arid lands. But it had a catch in it. The homesteading unit in the law was 640 acres, but a portion of this had to be irrigated within a certain time period. Few of the settlers could fulfill this condition, and irrigation companies reaped most of the benefits of the new law. Without irrigation, these 640 acre units were still too small for successful homesteading. However, this law did speed the irrigation of some western lands even though it helped few of the settlers it was intended to help. The Timber Cutting and Timber and Stone Acts of 1878 had similar results, with mill owners and lumber companies benefiting most from these laws.

In 1891, Congress finally passed an omnibus land bill that reversed the course of wanton exploitation encouraged by earlier laws. This law was the first to set aside forest preserves. Under President Theodore Roosevelt, an additional 140 million acres were added to these preserves, and the National Forest system was established.

Despite the change in land policy begun in 1891, the force of earlier laws still prevailed. More land was homesteaded in the first decade of the twentieth century than in the previous decade. But the end of homesteading was in sight. The last gasp was the Stock-Raising Homestead Act of 1916, which classified land that was only good for grazing into 640 acre units. (But not much grazeable land was left under public ownership.) Soon the remaining public domain would be withdrawn from homesteading. The era of escaping the tribulations of farm life by taking up new lands was over in the West.

Settling the West through homesteading was a painful process. Too much land went into agriculture too rapidly. Had there been a slower-paced, wiser program, land not suited to tillage or grazing could have been withheld from settlement. Theoretically, many of agriculture's land use problems in later years could have been avoided. The Homestead Acts set the

stage for later disasters such as the Dust Bowl, wasted forests, ravaging floods, over-supplied markets, and critical soil erosion.

World War I and Its Aftermath

Agriculture expanded rapidly during and after World War I. Agricultural methods changed quickly, and the size of farms grew. Mechanization started in earnest as the use of gasoline engines began to replace horses. Railroads spanned the country, and refrigeration allowed shipments to distant markets. Agriculture became regionalized--the wheat belt in the Great Plains; corn-hog farming in the Midwest; fruits and vegetables in California and Florida; livestock in the West; cotton in the Southwest; and dairy farming and specialty crops in the Northwest.

Yet, despite this progress, our farming system failed to maintain the basic soil resources. Even with the advent of soil surveys, soil erosion continued to be largely unrecognized as a threat. World War I accentuated this problem as farmers went all-out to win the war with food. Wheat acreage in the Great Plains was expanded far beyond the capabilities of the land.

Then, after the war, export markets that were insatiable during wartime soon disappeared. All at once, oversupply became a farm problem of stupendous proportions. Attempts made in the 1920's to alleviate this problem met with little success. The pressure for maximum crop production that started during the war continued in spite of surplus crops. Small operators were squeezed out as farming became more commercialized. No more virgin lands remained, and farmers finally had to adapt to staying on the lands already in use. In the 1930's, agriculture reached its maximum physical size; there were 6.5 million farms on nearly 1 billion acres supporting a population of 32.5 million people in farm families. A crisis was clearly in the offing.

During the 1920's, erosion was widely accepted as an inherent part of farming. Erosion received little attention until an obscure soil surveyor in the old Bureau of Soils began writing about its effects on the land in southeastern states. This man was Hugh Hammond Bennett. He was destined to become the apostle of soil conservation and one of the immortals of the soil conservation movement in the United States. He had begun to write and talk on the subject in 1918, but it was not until 1928 that he was able to put his story into a USDA publication. In collaboration with W. R. Chapline, an inspector in the Forest Service, he published "Soil Erosion, A National Menace" (USDA Circular No. 33, April 1928).

In this publication, Bennett estimated the annual loss of soil to be 1.5 billion tons and the wastage of plant food to be 126 billion pounds. Chapline summarized, "The toll the West has paid to soil erosion is enormous. Countless slopes, once covered with rich soil and dense carpets of herbaceous and browse plants capable of profitably supporting millions of cattle and sheep, have been so wasted by sheet and gully erosion following depletion of the vegetation that they can now support far less than half the number of livestock that once grazed upon them." The term "sheet erosion," first used in this publication, was especially significant. While gully erosion is prominent and easy to observe, sheet erosion (the

floating of thin layers of topsoil without evidence of cutting action) is difficult to recognize and therefore more insidious. Bennett found that sheet erosion was prevalent and very serious even where erosion had not previously been noted, and on many virtually level lands. He stressed the relation of erosion to flooding and siltation and its negative effects on the welfare of localities as well as farmers. He concluded, "...after 24 years spent in studying the soils of the United States, (I am) of the opinion that soil erosion is the biggest problem confronting the farmers of the Nation over a tremendous part of its agricultural lands...a little is being done here and there to check the loss...an infinitesimal part of what should be done."

The Federal Government began to study the problem at 10 erosion research stations in cooperation with state agricultural experiment stations. Bennett was assigned the job of establishing these stations. Just as the first experiments were underway, a crisis took place that required more action by the government. The severest drought and worst economic depression in the country's history infinitely accentuated the erosion problem. The drought increased wind erosion and made soils with poor cover very susceptible to water erosion. The depression left farmers unable to pay their mortgages, let alone take care of their land.

Depression, Drought, and the Dawn of the Conservation Era

In the 1930 U.S. Department of Agriculture Yearbook, the Secretary of Agriculture stated, "That soil erosion is a national menace is now recognized. The appropriation by Congress of $160,000 for its study is an evidence of this recognition." In 1931, a National Land Conference called for "a national inventory and classification of our land resources," among other recommendations, and "advocated an expansion of the department's soil conservation program." At long last, the severity of soil erosion was being recognized.

As the administration of President Franklin D. Roosevelt began, the depression had forced some 11 million people from their jobs, creating an emergency of unprecedented proportions. At the same time, millions of acres of farmland were so badly washed and blown that quick government action was imperative. These problems were further aggravated by an outpouring of unemployed people from the cities seeking economic self-sufficiency, usually on "submarginal" farms.

On March 9, 1933, the new administration proposed a Civilian Conservation Corps (CCC) to combat some of these problems. It was the President's idea that perhaps a half million idle young men could be put to work in the forests, on farms, and along streams where our natural resources needed help. Existing departments were used to carry out this new endeavor. By July 4, 1933, 275,000 youths and older men were enrolled in the CCC in nearly 1,300 work camps administered by the Departments of Agriculture and Interior.

The results of conservation and forestry during the first year were impressive; 950,000 acres of forest stands were improved; 420,000 erosion control check-dams were built; 100,000 acres of trees were planted; and

nearly 4,000 miles of fence were built. More than a half million man-days were devoted to fighting forest fires. USDA reported that in the first 2 years the CCC had "...pushed forward conservation programs by 10 to 20 years." During this emergency period, which ended with World War II, more than 3 million people served in the CCC.

Even though valuable conservation planning was done earlier, it was not until the CCC was formed that foresters and conservationists were given resources to put their plans to work. The CCC attacked conservation problems in many ways. It worked to protect forests; control soil erosion, grazing, and floods; develop land for public use; and conserve water. During the last year of its work, the CCC was using almost one-third of its work force on erosion control.

The Soil Erosion Service was created on August 25, 1933, in the Department of the Interior. It was given $5 million of public works funds to employ men on erosion control projects. Because of his 30 years of experience in the field, Hugh H. Bennett was selected as Director of the new agency. He was convinced that there were no panaceas for land use problems that had grown over a period of 300 years. He realized that each region and community was distinctive and that each farm presented a distinct set of problems. Therefore, a "custom-tailored" approach was essential; "standard" plans would not fit well enough. Since the farm was the economic unit, the entire farm was the logical planning area. This was the cornerstone of his philosophy for erosion control.

Farms are made up of a variety of soils, each having its peculiar potentials and limitations for various uses. Hence, solutions to land use problems must be based first on the soils involved. Cropland grows plants that require tillage, pastures grow forage for grazing livestock, woodland grows trees for wood products, and other lands may be habitat for wildlife or used for homesteads, recreation, or other purposes. Each land use has its own effects on soils and erosion, requires its own special treatments, and involves one or more of the agricultural sciences, each of which has its own kind of scientist. Therefore, the new Soil Erosion Service was staffed with a variety of technical people--agronomists, engineers, soil scientists, biologists, foresters, economists, nurserymen, and hydrologists. Along with these came a new breed of general scientist, the "soil conservationist." Working together, they approached erosion control as a team and offered coordinated programs of land treatment tailored to individual conditions. This was a radical change from earlier practices. In the past, each scientist had operated in his own "subject cell" and was insulated from others by agency boundaries.

The new agency established demonstration projects in watershed areas where the erosion problems were representative of those throughout the country. Bennett stressed that watersheds were logical areas for projects since they directly related to the action of water and to the by-products of runoff and erosion--floods and siltation. Farmers in the watershed project areas were invited to work out "cooperative agreements" with the government under which they would receive technical assistance in developing "conservation plans" for their properties. After a mutually acceptable plan was completed, the government assisted each farmer in carrying it out by supplying

certain conservation materials (seed, planting stock, lime, etc.) and by furnishing labor from work relief projects. Thus, erosion was controlled, unemployed people were put to work, and business was stimulated all through a single program.

With so much activity on thousands of farms in all parts of the Nation, it was not surprising that the need for technical answers soon outgrew the level of knowledge on soil conservation obtained by the original 10 research stations authorized in 1930. Emergency situations often required trial and error solutions. Thus, much of the soil conservation program which developed so rapidly in the ensuing years came into being through field testing on operating farms. Errors were made, as would be expected. But out of this process a program was forged that would receive worldwide acclaim. Under this program, each acre of land was put to its best use and received conservation treatment that met its particular needs.

In spite of this good start and the surprisingly wide acceptance of conservation, the nadir of agriculture in the United States was soon to be reached. On May 11, 1934, the first of the great dust storms occurred, sweeping the pulverized topsoil of parts of Texas, New Mexico, Colorado, Oklahoma, and Kansas across the country and dumping it as far as 300 miles into the Atlantic Ocean.

In response to this disaster, Congress passed the Soil Conservation Act early in 1935 making erosion control and soil conservation a permanent national policy. Since the law provided that existing organizations should be used to form the new agency, the Acting Secretary of Agriculture ordered that the Soil Erosion Service become the Soil Conservation Service (SCS) with status as a regular bureau of the Department (Memorandum 673, April 27, 1935).

By June 30, 1936, the Soil Conservation Service was operating 147 demonstration projects, 454 CCC camps (some of which were in project areas), 48 plant and seed nurseries, and 25 experiment stations (in cooperation with the land grant colleges). The demonstration program was already a success. There were tens of thousands of "conservation farmers" who understood and practiced proper land use and conservation treatment.

Nevertheless, many difficult problems were encountered. Some were technical; these were generally resolved through research and testing. Most of the persistent puzzlers were economic, social, or organizational. A needed conservation practice was expensive but brought in no income, at least not directly. Its benefits to the land and the community were clear enough, but could a farmer who was still struggling in the agricultural cost-price squeeze afford it? A large proportion of the Nation's farms were tenant-operated, having absentee owners. How could you get permanent conservation improvements when the tenant had inadequate future security and the owner didn't understand the need for the investment? In some areas, land use adjustments were critically needed in the public interest. Should recalcitrant owners be forced to accept land use regulations? With only a minute proportion of the Nation's farmers located in the demonstration areas, how could the benefits of the new technology be made available to the millions of farmers elsewhere?

These concerns were addressed in a long series of laws and other actions aimed at bringing about sound land use and preventing and controlling soil erosion. While most of these actions were taken by the Federal Government, many were also taken by state governments and cooperating individuals. The more significant of these actions involved research and education, technical assistance, financial help, and organization for action. One of the most significant actions was the passage of the Soil Conservation and Domestic Allotment Act in 1936. This act established a federal program for cost sharing with landowners and operators to cover the costs of installing conservation measures on the land. It also expanded on-farm technical assistance as well as conservation and education.

Research and Education

Conservation Experiment Stations

The opening gun in the fight against erosion was the establishment of the 10 original cooperative experiment stations which studied erosion and how to control it. The first money became available in late 1929, and some stations were set up in 1930. Most did not really get under way until 1931 or 1932. Later, 9 of the 10 stations published the results of a decade of study.

Measuring erosion and water runoff using control plots was only part of their work. Experimenting with methods to control soil erosion was the prime function of these stations. The results of these tests made up the bulk of their published reports. Techniques worked out at these stations were further tested in operations on farms. As they proved themselves, these techniques were incorporated into technical recommendations and published in bulletins for landowners.

Soon after the 10 original erosion research stations got underway, a number of others were established. These were also cooperative undertakings by the Department of Agriculture and the State Agricultural Experiment Stations. They served problem areas not covered by the first group.

As time progressed, the work of these stations was phased out. Research was continued, however, on many of the regular state experiment stations as well as within USDA. Most of the work continued to be done on a cooperative basis just as it is done today.

In recent years, erosion research projects have been aimed at specific problems or at particular areas. Hundreds of these projects have been undertaken. They have generated scores of progress reports and final publications.

Today, there is a much greater understanding of how erosion works than there has been in the past. Researchers have photographed the impact of raindrops on bare soil ("splash erosion") to show how the energy of falling drops dislodges soil particles from the surface. The kinetic energy of falling rain and runoff water has been measured and related to different kinds of soil. Researchers designed artificial rainmaking devices to simulate rain and measure its effects under controlled conditions.

Researchers also worked out techniques for estimating the soil losses from wind and water erosion that would occur on fields under various combinations of crops and conservation practices. For water erosion, these "soil loss equations" take into account the local rainfall factor, the soil erodibility factor, slope length, slope gradient, a cropping-management factor, and the conservation practices. For wind erosion, the equations include a soil erodibility index, a soil ridge roughness factor, climate, field length along the prevailing direction of wind erosion, and the vegetative cover. These equations enable a conservationist to predict the erosion consequences of any program a farmer might undertake.

The original research stations studied the effectiveness of different vegetative covers and mechanical conservation practices in controlling erosion. These subjects are still under continuous study. Crop rotations, various grass covers, use of crop residue, stubble mulching, and fertility treatments are examples of measures that enable crop vegetation to do a part or all of the job of controlling erosion. Some of the mechanical methods studied are terraces, diversions, contouring and grading of rows, stripcropping, landforming, land leveling, and tile drainage.

Soil conservation programs are perpetually changing as better methods are devised. New methods are often necessitated by changes in agriculture. The use of large farm machinery has required revisions in terracing practices to provide for parallel rows that accommodate larger equipment. The use of new chemical herbicides has necessitated changes in some agronomic practices such as no-till farming. Research in erosion control, as in conservation itself, is a never-ending job.

Education and Information

The knowledge gained through research must be disseminated if conservation programs are to be effective. Knowledge about resource conservation, including erosion control, is spread through the mass media and teaching in schools and colleges.

Education and publication on erosion control grew rapidly, beginning in the late 1930's. All of the land grant colleges and many others began courses in soil conservation and resource management. Some developed full departments or college majors in these subjects. High schools began adding soil conservation materials to their courses on biology and general science. University Extension Services added "extension soil conservationist" positions to their staffs. Large private companies dealing with farm machinery, fertilizers, and the like hired soil conservationists.

Printed material became available on every aspect of these subjects and served every level from grade school to graduate research. Books, bulletins, and articles in the press and journals spread the new knowledge. In recent years, many comprehensive bulletins and handbooks have been published for particular states and regions, including the Corn Belt, Southern Piedmont, Northern Coastal Plains, and the Sandy Soils of the Great Plains. In addition, the problems of erosion in nonfarm areas have received increasing attention in recent years.

Most local radio stations, especially in the more rural areas, cover erosion and conservation on their farm programs. Television stations often have local farm programs that include information on soil conservation. Many motion pictures have been made on the soil conservation theme. An early one, "The River," received wide acclaim as an outstanding documentary. Public meetings ranging from the local grange to national academies have heard the erosion tale from professional and lay speakers.

Technical Assistance in Erosion Control and Conservation

The Soil Conservation Service (SCS) continued the demonstration program of the Soil Erosion Service for several years as new technology went through its developmental and testing stages. Beginning in 1937, with the start of the soil conservation district movement, SCS began to phase out the demonstrations. By World War II, the demonstrations were completed. After that, technical services were available only to landowners in organized soil conservation districts. Within the next two decades, virtually all the rural land in the 50 states (other than the large areas of federal land) was organized into these districts. Therefore, technical soil and water conservation services were available to private landowners throughout the country. Some 2 million farmers and other rural property owners have been given technical assistance through conservation programs.

Financial Help in Erosion Control and Conservation

Cost was and is a major problem in erosion control and other conservation work. During the depression, farmers were in severe financial straits. It was difficult for them to finance even the most urgent investments. The erosion control that the country wanted was rarely at the top of the farmers' list of priorities. Beyond this there was the broader problem of who should pay for conservation investments. Some of the benefits from controlling erosion accrued directly to society; only a part of the benefits aided the landowner. Thus it was readily agreed that the public should pay a part of the cost of conservation work on private lands, at least for that part that had clear public benefits.

Financial assistance from the Federal Government has generally taken the form of grants or loans. Grants have been used mainly to share the cost of specific work. The government has made grants to individual landowners, groups of landowners, and small organizations such as watershed associations. Conservation loans have taken several forms and also apply to individuals, groups, or organizations.

Many states have also provided financial help for conservation work. This has occurred mostly in the fields of forestry and wildlife management where the control of erosion was incidental.

Agricultural Conservation Program

In 1936, Congress passed the Soil Conservation and Domestic Allotment Act which established a cost-sharing plan for soil conservation. In the early years the emphasis was on furnishing conservation materials, especially lime and fertilizer. The federal cost sharing for these two materials was

instrumental in encouraging conservation farming and the growing of legumes in crop rotations. This greatly improved soil productivity. Additional practices were made eligible for cost sharing over the years. Now the eligible practices are recognized soil, water, cropland, grassland, woodland, wildlife, or outdoor recreation measures based on the land and water resources and those which control pollution and improve water quality.

Many of the practices in the ACP are aimed directly at the control of erosion; others help incidentally. These practices include establishing various vegetative covers, mulching, stripcropping, terracing, special tillage operations, and animal waste control. The number of participants receiving ACP cost sharing has ranged from a maximum of 6.5 million in 1943 to the current level of about 1 million a year.

Water Bank Program

In 1970, Congress established a program to conserve water and to preserve and improve migratory waterfowl habitat and other wildlife resources. This program is based on long-term land use agreements with landowners who live in important migratory waterfowl nesting and breeding areas. For a period of 10 years the landowner agrees not to drain, burn, fill, or otherwise destroy specific wetlands. USDA makes annual payments to the landowner based on the agreement.

The Water Bank Program applies to 155 counties in 12 states. It is the only USDA program that is directed solely at preserving wetlands. Each year approximately 70,000 additional acres are protected by about 600 agreements. Since fiscal year 1972, 4,600 agreements have been signed. They cover about 500,000 acres of land.

The Water Bank Land Rental Program complements the Department of the Interior's Wetland Acquisition Program.

Forest Incentive Program

The Forest Incentive Program encourages the development, management, and protection of nonindustrial private forest lands. Its goal is to increase the production of timber and to enhance forest resources.

The program was first established in fiscal year 1974. It is carried out through annual and long term cost-sharing agreements with private landowners who plant trees or improve an existing stand of forest trees. To date, 1,450 counties have participated in this program. A recent estimate showed that more than 1.2 million acres of trees have been planted and timber stands have been improved.

Though the major goal of this program is to increase timber production, it has also benefited conservation. Tree planting on lands that are highly erodible and ill suited to continuous cropping provides permanent land cover, reduces erosion and sedimentation, and improves the land's ability to support sustained use.

The Appalachian Land Stabilization and Conservation Program

Through the Appalachian Land Stabilization and Conservation Program, cost-sharing and technical assistance are provided to landowners, operators, and occupiers for land stabilization, erosion and sediment control, reclamation through changes in land use, and the establishment of practices and measures for the conservation and development of soil, water, woodland, wildlife, and recreation resources.

The Appalachian Regional Commission recognized that the limited amount of funds available for land treatment measures required concentration of contracts by area if the impact of the program was to be significant. Therefore, project areas were directly related to developing or enhancing the development potential of a state-designated growth area.

Farmers enter into a long-term (3-10 years) contract to carry out conservation practices developed under the state program. Cost sharing is available at 80 percent of the cost of the conservation practices. Assistance under a contract is limited to 50 acres of land on the eligible farm. In 1977 contracts were in effect on 4,112 farms in 13 states, to assist in meeting the conservation needs on 137,075 acres.

Funds for the Appalachian Land Stabilization and Conservation Program were appropriated by the Congress under the authority of the Appalachian Regional Development Act of 1965. The annual state program funds were authorized by the Appalachian Regional Commission.

The programs for the states were developed cooperatively by the state government and USDA agency representatives. They were approved by the Appalachian Regional Commission, and are being administered by the Agricultural Stabilization and Conservation Service through its state and county offices. Technical assistance was provided by the Soil Conservation Service and the Forest Service.

Loan Programs

In the depression years, Congress recognized that credit would have to be liberalized to enable landowners to improve their farms. Needed improvements included all kinds of conservation work, beginning with erosion control. Over the years Congress has authorized a variety of loan programs to meet the needs for these improvements. The basic loan program is called Farm Ownership Loans. These loans enable individuals to acquire a farm or to enlarge or improve an existing farm. They cover improvements on buildings and facilities in addition to work on soil and water resources. There is also a special program of Soil Conservation and Water Development Loans for individual landowners.

Two aspects of these conservation credit programs deserve special attention. First, each borrower is given continuous professional counseling throughout the loan period. While this counseling is aimed mainly at farm management, a part of it is directed at erosion control. The technical assistance, cost sharing, and credit received by the borrower are all closely coordinated. A borrower is encouraged to develop a soil conser-

vation plan for his farm; in some cases, this is made a condition for granting the loan.

State and Local Aid

Organizations outside of the Federal Government also aid farmers for a variety of reasons. State governments have a special interest in achieving improved forestry and wildlife habitat on private lands. Local governments, generally counties, cities, or townships, are especially concerned about water supplies. Private industry also helps because it wants to sell its farm machinery and irrigation equipment to farmers.

In one way or another, all of these organizations generate certain kinds of aid to landowners. Much of this help has indirect benefits for conservation and erosion control. State forestry agencies may give away or share the price of tree seedlings for reforestation. They may also offer timber marketing facilities. State wildlife agencies often offer free planting stock and supply seed and fencing to improve habitat for game. Some organizations provide all or a part of the labor or cost of doing the work. Some will build dams to develop water facilities for wildlife on arid land. Some buy easements for the hunting or fishing rights and then invest in improving the lands and waters.

The variety and extent of the financial aid offered depends on the major interests in each state and area. It is clear, however, that there is a substantial amount of help in cash and services for landowners who will use conservation treatments to improve their properties.

Organization for Action

It is one thing to create government agencies and appropriate public funds with the goal of controlling erosion and conserving soil; attaining these goals on most of our land is another matter. In the National Forest and public domain, the Federal Government can perform whatever conservation work it wishes. But it does not have control over private land, and 67 percent of our land is nonfederal. Ninety-nine percent of this nonfederal land is outside of Alaska. There are no laws that specifically prohibit a landowner from causing virtually any amount of erosion. Except under unusual circumstances, erosion is controlled only through voluntary action. Therefore, the importance of enhancing the opportunity for citizen-government cooperation is apparent. Citizens have organized for cooperation in erosion control and other purposes in a number of ways.

Soil Conservation Districts

The direct government-landowner relationship used in the pilot erosion control demonstration projects worked well in the mid-thirties. But to effectively reach and work with millions of independent landowners was more difficult. It would require widespread local leadership to motivate and guide such a large number of landowners.

The answer was a new unit of local government, the soil (or soil and water) conservation district (SCD) which was legally organized and operated under

state law. Its purpose was to serve the interests of landowners by bringing them the facilities and services of the federal and state governments and by helping them plan and apply conservation measures.

A model "Standard State Soil Conservation District Law" was prepared for the consideration of state legislatures. President Roosevelt recommended this model legislation to state governments in a letter on February 27, 1937. It proposed a state policy for conserving soil and water resources and procedures for creating local districts to carry out conservation programs. The proposed districts would be run by boards of supervisors. They would have authority to carry out conservation work in cooperation with landowners or land users, conduct surveys and investigations, receive assistance from other agencies, and perform other functions. The district, through a referendum, could establish and enforce land regulations.

This model legislation helped realize the concept of a conservation program carried out under local control with help from federal and state agencies. The states were quick to accept the need for such a law. Arkansas passed its act just a few days after receiving the President's recommendations on March 3, 1937. Within 5 months, 22 states had passed similar laws patterned to varying degrees after the Standard Act. All the states had soil conservation district laws by 1947. On August 4, 1937, the first district was organized under these laws--the Brown Creek S.C.D. in Anson and Union Counties, North Carolina. Fittingly enough, this was Hugh Bennett's home country.

The phase-out of the demonstration projects was completed early in the 1940's. The creation of conservation districts continued until, by the mid-1960's, virtually all private rural land was included within their boundaries. More than 3,000 districts are now operated by some 14,000 conservation conscious citizens, most of whom are elected.

Each soil conservation district entered into a memorandum of understanding with the Secretary of USDA, and another with the Soil Conservation Service. These memoranda are the bases for the technical assistance made available to district cooperators. Such assistance is predicated on the district developing a long range program for the soil and water conservation that is acceptable to the Secretary of Agriculture. This program is used to determine the amount and kind of assistance to be provided by USDA agencies.

The circumstances that created the new era in soil conservation also spurred a renaissance in other areas of resource conservation. The Taylor Grazing Act brought order out of chaos on the remains of the western public domain. The Federal Waterfowl Refuge System was created through the action of J. D. Darling and Ira Gabrielson. The Tennessee Valley Authority undertook major watershed renovation. The Flood Control Act of 1936 recognized upstream flood control as a necessary partner to the major river works. Guided by Gifford Pinchot, forestry made great strides. The new field of managing land and water resources for wildlife was inspired by Aldo Leopold. Cooperative federal-state programs in this field were begun under the Pittman-Robertson and Dingell-Johnson Acts.

As time went on and the concept of soil conservation programs broadened, the responsibilities of SCS grew. SCS was assigned responsibility for flood control surveys under the Flood Control Act of 1936 (together with the Forest Service and Bureau of Agricultural Economics); action phases of the Water Facilities Act of 1937 (later transferred to the Farm Security Administration); administration of the Land Utilization and Retirement of Submarginal Land Programs under the Bankhead-Jones Farm Tenant Act of 1937; farm forestry programs under the Cooperative Farm Forestry Act of 1937 (later returned to the Forest Service); demonstration on the construction and hydrologic phases of farm irrigation and land drainage (including 36 CCC drainage camps) and inclusion of irrigation and drainage in the general soil conservation program; the snow survey in western states; flood control operations on predominantly agricultural lands; and in western states, the Water Conservation and Utilization Programs under the Case-Wheeler Act.

The period from the early 1930's through World War II, which included the twin catastrophes of depression and drought, was one of great complexity and tremendous change in the Nation's agriculture. These great adversities, however, proved advantageous in forcing long delayed solutions to soil, water, and land use programs. For the first time, the fundamental importance of our land resources was truly appreciated. When we went into World War II, we were better prepared to absorb its impact on our resources because the Nation had entered the Conservation Era.

World War II and the Technological Revolution

In contrast to World War I, there was no large scale increase in the amount of land plowed during World War II. Production was increased mainly through greater efficiency. The land was used more intensively, however, which took some toll on the soil. Because of the pressures of war production and the shortage of labor, much routine conservation work was postponed.

As in most wars, the aftermath of World War II brought famine and the threat of famine to many parts of the world. Much of Europe's best farmland was either devastated or its production facilities were impaired.

Drought in parts of Europe and North Africa reduced output in 1945-46. A food crisis occurred in the Orient. From 1945 to 1949, the United States furnished more food to the hungry peoples of the world than any nation before or since.

The technological revolution initiated by World War II continued at an accelerated pace after the war. The technological advances in equipment and materials made during the war were used to improve machinery and chemicals for agriculture. The wartime spur for production had generated new commercial fertilizers, chemicals for disease and plant control, better conservation practices, prepared livestock feeds, and a host of other products affecting farming.

Despite substantial drought in the country throughout the 1950's and a renewal of fairly severe dust storms, agriculture increased its productivity 6.5 percent each year after 1950. Other industries only increased

their productivity by 2.0 percent annually during this period. The increase in agricultural productivity was dramatic. In producing wheat on the Great Plains, for example, one man could now do work that once required more than thirty.

This technological revolution involved more than direct inputs on the farm. Better credit, improved processing and marketing, and advances in transportation promoted greater specialization in farming. This, in turn, had tremendous impacts on land use. As agriculture became more efficient, land could be chosen more carefully for specific uses. As a result, the extent of "submarginal" lands and the problem of what to do with them increased, while the amount of good land also increased and, in fact, exceeded current needs. This was true despite our rapidly increasing population and continually expanding domestic market. As land use became more selective, it also became more intensive, which made conservation treatment more urgent than ever.

Consequently, the "farm problem" that had bedeviled farmers, agriculturalists, and politicians from 1920 through World War II returned with a vengeance in the mid-1950's. Basically, this problem had not changed--our agricultural plant was too big for our markets. Virtually every year, the Congress tried a new tack to solve it: high, rigid price supports; flexible price supports; acreage allotments; marketing quotas; encouragement of land diversion; and so on in various combinations.

Land Retirement and Diversion Programs

In 1956, the Congress decided to try another approach. Since the problem resulted from having too much land in production, why not subsidize a noncrop, conservation use for some land? This approach would attack two problems at once--the surplus of crops and the conservation treatment of land. The idea, which was extremely popular with many conservation groups in the country, became the basis for the Soil Bank. At first the Soil Bank had two parts: (1) an "acreage reserve" under which the government rented cropland for a year; and (2) a "conservation reserve" under which farmland was placed in a conservation use such as woodland or wildlife habitat for up to 10 years. Special inducements were offered if an entire farm was placed in the conservation reserve.

The acreage reserve attracted 21.4 million acres in 1957; it was abandoned in 1959. The first year the conservation reserve brought in 1.4 million acres. By 1960, the total land placed in the conservation reserve was 28.6 million acres. Extra subsidies were offered for needed treatment on these lands, including tree planting, seeding and planting wildlife habitat, and water developments.

Had this great area of tens of millions of acres been a true reduction from the high-producing croplands of the Nation, the crop surplus problem surely would have been solved. Unfortunately, very little of the better cropland was brought into the conservation reserve; the fields offered for diversion were generally the poorest on the farm. As a result of the ongoing technological explosion, production on the remaining croplands continued to increase, and there was no overall decrease in the supply of farm commodities.

A pilot program called the Cropland Conversion Program began in 1963 and was followed by the similar Cropland Adjustment Program. By 1967, these programs had about 4.5 million acres under contract. The Feed Grains Program, which began in 1961, has placed about 20.3 to 34.8 million acres a year under contract. A special Wheat Diversion Program has operated since 1962 and a Cotton Diversion Program since 1964. They have reduced the acreage in these crops from 4.9 to 10.7 million acres per year. In all of these annual contract diversion programs, the landowner was required to use an appropriate cover crop or other means of preventing erosion.

"The basic physical objective of soil conservation activities by Department agencies shall be the use of each acre of agricultural land within its capabilities and the treatment of each acre of agricultural land in accordance with its needs for protection and improvement." This statement by the Secretary of Agriculture in 1951 made Department policy of a slogan used by the Soil Conservation Service (SCS) for many years--use each acre within its capability, treat it in accord with its needs.

This move illustrated the growing effort to coordinate the land use work of the Department into a unified program. The soil survey work of the Department became the responsibility of the Soil Conservation Service. Technical services, education, research, cost sharing, economic analysis, credit--all were becoming more closely knit. Farmers borrowing for soil and water improvements were developing conservation plans for their farms; cost sharing was based on conservation need; technical services were provided to participants who had conservation cost sharing and loans.

In 1956, the "Great Plains Conservation Program" was set up to attend to the problems of wind erosion in the semiarid Plains States. This regional program is directed wholly at the special erosion and conservation problems of the Great Plains. It involves 419 counties in 10 states. Under this program, farmers and ranchers can undertake a long term plan and contract with the government that includes arrangements both for technical services and cost sharing. Among the 25 conservation practices eligible for cost sharing under this program, the most prominent are concerned with establishing and improving grass cover, controlling erosion on cropland (including terracing), and improving water facilities.

The technical aspects of conservation programs advanced steadily with the technological revolution. Practices and systems that were developed to broaden and perfect the Nation's soil and water conservation programs include: parallel terrace systems; stripcropping and terracing gauged to multiple-row machinery; widespread leveling of cropland to facilitate irrigation and drainage; cooperative systems for irrigating and draining, often in conjunction, in multiple-farm areas; improved varieties of conservation plants; better methods of seeding and tillage designed to reduce erosion; the interpretation of soils for a variety of nonfarm uses; and the incorporation of outdoor recreation practices in conservation plans.

As the conservation services offered to individuals grew, the need to further broaden the land use programs became evident. Problems continually arose that could not be resolved by the individual farmer alone, nor by a small group of cooperating farmers. Area, community, and watershed

problems required a different approach. Congress provided the means for attacking such problems with several new laws.

In 1954, Congress passed the Watershed Protection and Flood Prevention Act, Public Law 566, which was later broadened with a number of amendments. This Act treats upstream watersheds to complement the river flood control work by the Corps of Army Engineers. Under this Act, natural watersheds covering 250,000 acres that have problems with flood damage, agricultural water management, and water supply can be developed through projects sponsored by local organizations. A plan is developed for the watershed and is carried out with federal cost sharing. In addition to protecting agricultural valleys from floodwater and sediment damage, these projects can cover community irrigation and drainage facilities, public or industrial water supplies, public water-based outdoor recreation, and fish and wildlife developments.

The water facilities loan program was broadened in 1954 to include loans to individuals, groups, watershed organizations, and soil conservation districts for soil and water conservation work. The Farmers Home Administration was authorized to cooperate with rural communities in developing projects for public water supply and sewage disposal.

Congress amended the Bankhead-Jones Farm Tenant Act of 1937 in 1962 and again in 1972 to provide for the development of Resource Conservation and Development Projects. These amendments facilitated resource planning on a broad scale, involving multiple-county areas, groups of soil conservation districts, and all public and private groups concerned with community improvement. These projects can center around a trading area but generally concern areas where natural resource conservation is a problem. They serve urban as well as rural interests. New hospitals, highways, and power lines are examples of possible projects; however, only those projects based on soil and water resources are eligible for federal cost sharing.

In 1972, USDA launched a national program of inventorying and monitoring to collect resource data on the status and condition of the Nation's natural resource base. The Forest and Rangeland Renewable Resource Planning Act of 1974 provides for periodic assessment of renewable resources and the development of a Renewable Resource Program. Congress passed the Clean Water Act of 1977 because of concern over water quality and nonpoint pollution from agriculture and silviculture.

Agricultural land use has improved greatly in the last 3 decades. In particular, croplands are now used much more nearly within their capabilities than before. Conservation methods are used widely. Appreciation of the need for proper land use and conservation treatment is almost universal. While the efforts of conservation programs have significantly increased the conservation use of soil and water resources, economic considerations have had a major impact on land use and conservation treatment. Many of the major regional shifts in land use have occurred because of economic conditions. An example is the birth of the grassland-livestock industry in the South, which caused a major reduction there in grain crops and soil erosion. The more intensive cropping of highly productive land in the Corn Belt reflects economic pressures as well as technological changes.

As farming has grown more competitive and specialized, water resources have greatly increased in importance. Supplemental irrigation is practiced now more than ever.

Almost all our farmland is privately owned. Thus, private agricultural enterprise provides the base for society's food and for much of its clothing and shelter. This basic fact has not changed despite the highly complex, industrial nature of our present society. Further, the welfare of our Nation's agriculture, and hence the welfare of our Nation's citizens, rests on the land as its base and on how that land is used.

From erosion experiment stations to grand regional development programs, the effort continues to save our land resources. This complex of programs and actions by government and individuals, which has grown only within the last half century, is probably the greatest effort in man's history to correct resource abuses and maintain the environment.

We know that:

1. Productive land is neither limitless nor inexhaustible. On the contrary, the area of productive land is steadily shrinking before the onslaught of erosion and the increasing use of land for roads, urban areas, and other nonfarm purposes.

2. Land must be expertly cared for if its productivity is to be maintained.

3. Productive land must assume a higher position in the priorities of our Nation. As the source of food for all our people, it must have regular, intelligent consideration in order to preserve the indispensable wealth it provides.

4. Since society as a whole depends on the land for its present and future existence, it must share in the responsibility and costs of maintaining the land's productivity. The individual landowner or operator has neither the resources nor the ability to carry the burden alone; moreover, he has control of his land only for a lifetime.

5. Science must devote a significant share of its attention to the problems of maintaining and improving the yield of productive land.

Whether or not all of the Nation's conservation programs--past, present, and future--can succeed in saving the land for the increasing millions in decades ahead is far from certain. However, it is imperative that the effort be made and be given the full cooperation of society.

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Chapter 12 - The Impact of Technology on Agricultural Production and Conservation

As in other fields, technology in agriculture has grown out of research and development. It is often viewed rather narrowly as a process used to increase the productivity of soil, water, forest, and wildlife resources, and to enhance resources. For the purpose of this report a broader view of technology is necessary, one that recognizes the social and economic incentives and constraints on the structure of the technical production package. Technical solutions that are not economically feasible or socially acceptable will not be implemented. In this context, technology can be defined as the combination of factors that permits continued output in a manner sanctioned or encouraged by society.

Current technologies exist because they provide economic incentives to producers and suppliers and because society agrees that their social or environmental costs are warranted because of the need to produce food and fiber and to preserve and improve our soil and water resources. However, society, business, and agriculture are continually negotiating over what is and is not desirable, economic, or necessary. Laws, regulations, and court decisions are changing the technological mix but to a lesser degree than new technical inputs resulting from research and development. Farmers are also developing innovative applications of old techniques. There are also attempts to adopt innovative regulations, programs, and laws to improve the acceptability of conservation practices and alternative types of production.

At the time of the American Revolution, farming methods differed little from those used during the Roman Empire. Although farmer-inventors began to develop labor-saving machines soon after the Revolution, it wasn't until the Civil War that the first agricultural revolution occurred. At that time, labor shortages, high prices for farm products, and the seemingly unlimited demand for food led farmers to adopt new horse-drawn machinery and to turn from self-sufficient to commercial farming.

During this same period, Congress enacted a series of agrarian reform laws which both reflected and promoted this agricultural revolution. These laws fostered family farms by creating homesteads. They also established land grant colleges and the Department of Agriculture. The newly constructed transcontinental railroad stimulated commercial agriculture by transporting homesteaders to new lands and by returning their products to eastern markets.

An examination of statistical data reveals the dramatic changes that have taken place in American agriculture. During the past 200 years, the percentage of farmers in the work force has declined from more than 90 percent to less than 4 percent. During the past few decades, the farm population and the number of farms have fallen sharply. In 1960 more than 15.6 million persons lived on farms, but by April, 1977, the farm population had declined to 7.8 million. The number of farms peaked at 6.8 million in 1935 and dropped to 5.7 million by 1950. Statistics released in December, 1977, showed the number to be 2.34 million (General Accounting Office, 1978).

Despite these declines, total farm production, with yearly variations, has increased tremendously. Since 1967, farm production per man-hour has

increased by 160 percent compared with a 115 percent increase in nonfarm business (USDA, 1978a).

World War II brought another agricultural revolution in America. Some of the causes were labor shortages, price guarantees for 2 years after the war, and urgent pleading by the government for increased production. In response, farmers changed to tractor-powered machinery and adopted a series of innovative techniques. These new techniques included specialized machinery, improved (often hybrid) seeds and breeding stock, conservation tillage, exact application of fertilizer, more productive use of water through irrigation or drainage, and application of chemicals to control weeds, fungi, and insects. These techniques were developed by researchers in USDA, the State Land Grant Colleges, and private industry. They were used as a package and this led to a total increase in agricultural productivity that was greater than would have resulted from using any one of them singly.

Irrigation has also played an important role in increasing productivity. Until World War II, streams and rivers provided most of the water for irrigation, primarily in the Mountain and Pacific regions. Since then, wells have taken over as the chief source particularly in the Plains States. According to the latest estimates, about 81 percent of the water consumed in the United States each year is used for irrigation (U.S. Water Resources Council, 1978). Although only 12 to 14 percent of the cropland is irrigated, irrigated cropland produces more than 25 percent of the total U.S. harvest (USDA, 1978a).

These technological changes have caused various environmental concerns. Many acres have become virtually useless because of salinity--the accumulation of salts in the soil. In parts of the Great Plains and the desert Southwest, the water table is so low because of continuous pumping that it is too expensive to pump more water for irrigation. In spite of studies indicating that the ground water supply for irrigation will be largely depleted by 2000, there has been no national policy to recognize or forestall such a development.

An adequate supply of fresh water is essential for agriculture, and more is needed than is presently available if production is to continue to expand. The reclamation of waste water and prevention of water pollution could make more water available for agriculture and other uses. The technology is already available to treat sewage so that the liquid content becomes inoffensive and nonpolluting. But present water laws (the doctrine of prior appropriation) do not provide incentives for water conservation. In fact, the potential loss of water rights is a threat to a conservation program.

Meister et al. (1976) quoted Charles J. Headley, who summarized agriculture's activity over the past decades:

> Adoption of industrialized technology is the method we chose to minimize the market value of resources devoted to agriculture. In that regard we have been effective. But the extra-market values sacrificed for cheap food and economic growth have not been as consciously economized, if at all. Our streams and lakes are muddy and contain a variety of

> man-made chemicals. Our ground water is suspect and the disposal of animal and processing wastes in certain localities impinges upon the natural environment in an unsatisfactory way. Communities have been depleted of their people as economic growth has spurred urbanization. At least part of our economic growth has been provided by living off the depreciation of both the countryside and the cities because the maintenance activities required to correct this depreciation result in an increasing gross national product (GNP).

Assuming Headley's thesis is correct, this situation has developed because of various technological advances and the consequent effect on agricultural production and conservation.

Barkley (1978) discusses how the unanticipated effects of new technology can change input mixes, income distributions, and consumer demands. When the various technological advances in agriculture are examined in detail, these effects can be seen more clearly. The General Accounting Office (GAO, 1978) and Little (1979) have given this area much study. Little directs his attention more toward emerging issues, while the GAO study deals with specifics in the changing scene in agriculture. The digest of the report states that "a series of cost-price squeezes, specialized technology, and the targeting of government farm programs has created a farm sector that has fewer, larger, and more powerful farms; less family labor; less diverse production patterns; and increasing dependence on purchased inputs, foreign oil, and markets outside the United States." In many instances the key to overcoming these problems is an economical source of energy. Obtaining a dependable supply of energy is one of the problems farmers will face in the future--by or before the year 2000. American farmers are now dependent on fossil fuel to operate machinery, heat homes, and produce fertilizer, particularly nitrogen.

The GAO Food Coordination and Analysis Staff found that specialized technology affected many areas. Mechanization was one technological change that particularly affected the conservation of soil, water, forest, and wildlife resources. As larger, more powerful machinery was developed, the entire agricultural system tried to find ways to make farmland more productive. There are about 4.5 million tractors in use in the United States today, twice the number in use in 1945. Further, the GAO found that in 1965 only 2 percent of the tractors sold had over 100 horsepower but that by 1976 nearly 50 percent were at least that powerful. Tractors with 750 horsepower are now available. Equipment of this size has in many instances required changes in the conservation system used by farmers. Grant (1979) noted that large equipment requires large acreages and operates more efficiently in a straight line on the field's longest axis. He also makes a case for the possible relationship between soil compaction and erosion and the use of large equipment. It needs to be pointed out, however, that the beneficial results from using larger equipment might include: (a) more timely tillage operations to reduce wind and water erosion; (b) working additional soil at more nearly the right moisture content; (c) compacting less total soil surface; and (d) possible lower unit compaction load when using large equipment.

The use of other resources in food and fiber production increased drastically during the fifties, sixties, and seventies. Fertilizer use per acre in 1978

was five times the 1950 rate, and the volume of pesticide sales increased by nearly the same magnitude (USDA, 1978a).

The increased use of pesticides and fertilizers is associated with increased crop yields and the need to increase return on capital invested in machinery and land. The number of soil tests conducted to help specify appropriate lime and fertilizer applications has generally increased to keep pace with farm productivity. The use of anhydrous ammonia increased from 4.0 million tons in 1971 to 4.9 million tons in 1977; available phosphate from 4.8 million to 5.6 million; and potash from 4.2 million to 5.8 million. Pesticide sales during this period indicate a threefold increase in the use of herbicides and a minor increase in the use of insecticides and fungicides (USDA, 1978a).

Research has demonstrated that, with the use of available technology packages, many pests can be controlled more efficiently, and often with reduced herbicide use. Programs have been designed and conducted to reduce injury to people and to the environment.

In spite of pressures, farmers have still increased production and output. According to the U.S. Department of Agriculture (1978b), the index numbers for total farm output range from 96 in 1963 to 121 in 1977. These figures assume a base value of 100 in 1967. The index increased or decreased by one to two points each year between 1963 and 1967. It showed a minor drop in 1970, increased until 1973, and plunged 6 points in 1974. The index has increased steadily since 1974. The USDA statistics reveal the same trend for the index of all crop production, although the increase in the crop index has been more dramatic since 1974, reaching a value of 129 in 1977.

Technological changes have had an impact on the use of conservation practices. Today, the acceptance of conservation practices involves an interplay among the farmers, the government, society in general, and the business community. The definition of conservation practices goes beyond the traditional considerations of soil and water management. It includes the impact of other farming practices on water and air quality, for example, management systems that reduce contamination of water and air by fertilizers and pesticides and their residues.

Consumers have welcomed technological changes brought about by research and extension that have reduced costs, increased supplies, and provided new products. Although some technological changes have produced undesirable effects, they are accepted by the beneficiaries of these changes. Such changes can be classified as 1) internal costs or trade-offs--those that are known about and accepted, and 2) external costs--those that may not be known about but generally are borne by others or are not covered in the pricing of the product.

For the producer, an internal cost would be the higher investment required for trickle-irrigation systems that save water. For the consumer, an internal cost would be higher prices for better quality produce that is larger and more appealing to the eye.

External costs include nitrate pollution of ground water, reduction of wildlife habitat because of land clearing and drainage, and injury to nontarget organisms caused by improper use of agricultural chemicals.

In recent years, some technological changes have adversely affected the conservation practices promoted by the USDA. For example, shelterbelts and terraces have been removed and the use of contour farming has been reduced in order to use larger and more energy efficient machinery. Other technical changes have had both positive and negative environmental effects. Minimum tillage has increased the vegetative cover, reduced soil erosion, and lowered the energy cost of tillage. At the same time, it has required an increased use of herbicides and other pesticides that can adversely affect water quality and wildlife habitat.

Another factor in conservation is the capital investment required. The Natural Resource Division of the Economics, Statistics, and Cooperatives Service, recently developed an historic series for the value of capital investment in irrigation, drainage, and conservation (IDC) since 1900, including both public and private investments (USDA, 1979). The study shows an overall decline in book value of soil and water conservation investments of $100 million per year since 1955. Drainage facilities have declined slightly since 1970 while irrigation investments have continued to increase.

The IDC facilities and associated equipment in 1975 had an aggregate net depreciated real value of $27.5 billion. They now represent about one-fourth of all fixed nonland capital in agriculture. The aggregate net value in 1975 was made up of about $12.3 billion for irrigation (45 percent), $9.7 billion for all conservation (35 percent), and $5.5 billion billion for drainage (20 percent). A tentative estimate for 1977 of the net value of all IDC capital was $27.9 billion, weighted slightly more toward irrigation than in 1975.

As of 1975, the Federal Government, through direct construction and by cost sharing programs, had created about 45 percent of the net value of all IDC facilities in the United States, varying from 8 percent for drainage, 52 percent for irrigation, and 55 percent for soil and water conservation. About 70 percent of the water management facilities, whether for irrigation or drainage, are of a group-project nature.

The decline in conservation capital is due to both a reduced level of investment and an increased level of depreciation or to the obsolescence of earlier investments. For example, farmers have been removing terraces at a faster rate than they have been establishing them. Farm drainage systems depreciated at a rate of $55 million per year from 1970 to 1975, while investment in new drainage systems averaged only $40 million per year. Farm consolidations have made some drainage systems obsolete.

The recent increase in land and crop prices indicates that the real value of these resources is not necessarily the same as their perceived market value.

In other words, as long as adequate supplies are available to meet market demand, the pricing system for natural resources does not reflect their real value. As shortages develop, the market accords them exceedingly high values. The ability of the output of these resources to respond to demand in the short term sets their market value. The current high interest rates

produce a discount rate emphasizing current rather than future economic values. Pavelis' comments (1973) are noteworthy at this point:

> The findings for conservation capital mean that new conservation investments, when deflated to real dollars, have not kept pace with estimated depreciation. The recent budgets for the Rural Environmental Assistance Program have likely suffered the most in this respect, although the Great Plains and Watershed Programs for soil and land conservation also seem to have lost impetus, at least when inflation is considered.

Since the initiation of conservation management in 1935, there has been a rise and more recently a decline of conservation capital in agriculture. Soil conservation cost-sharing programs expanded rapidly through World War II. Since the peak year, 1955, the real value of conservation improvements has fallen because depreciation has more than offset net new investments.

In effect, depletion of the resource base contributes to higher value of the remaining resources and hastens the time when conservation becomes economical. To a conservationist this is unreasonable. The market should look farther ahead than 10 to 20 years regarding the conservation of natural resources. In a sense it does. Speculative values in land, however, may sometimes be sustained by soil-depleting rather than soil-enhancing practices. Nevertheless, the economist should be able to analyze the problem and devise investment credit incentives for conservation as readily as for fixed capital in industry.

Recently, increases in plant productivity through genetics and pest control have been substituted for the maintenance of the resource base. Some researchers say that yield plateaus are now being reached and that this process can no longer continue (National Academy of Sciences, 1975). This question needs to be examined in greater depth.

The economics of conservation indicates that onsite costs need to be related to more than the short-term benefits. Conservation structures need to be treated as capital investments like barns, storage, and other capital items. Society will probably also need to continue to share the cost of conservation because of its offsite value. Conservation research needs to develop conservation measures that are nonstructural and less costly.

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PART V - PUBLIC PARTICIPATION

Chapter 13 - The Public's Role in the RCA Process

Background

Public participation is an important feature of the Soil and Water Resources Conservation Act (RCA) of 1977 (Public Law 95-192). The Act mandates cooperation between the Secretary of Agriculture and the conservation districts, state and local agencies, and other appropriate groups to ensure public participation in developing a national soil and water resources conservation program. Further, the law requires that the public be provided with information developed during the appraisal and program formulation.

The purpose of public participation is to--

- identify values held by the public
- critique the appraisal and program
- increase interest in resource conservation as a national concern
- identify potential supporters for a national conservation program

The following are the long term objectives:

1. Make the public aware of and keep them informed about the features of RCA, including their role in the process.
2. Make the public aware of the condition of the Nation's resources and the importance of developing a national soil and water conservation program.
3. Encourage people with diverse interests to contribute information, express views, and assist decisionmakers in developing the program.
4. Consider all views expressed by the public.
5. Inform the public about the national conservation program that results from RCA.

The first major RCA activity was a series of four workshops in December 1977 and January 1978, one at each SCS Technical Service Center (TSC). The purpose of these meetings was to explain the provisions of the Act and to discuss planning and implementation. Participants included state conservationists and one or two others on their staffs, two to four representatives of the host TSC, and two to six Washington Office personnel. Representatives of the state soil and water conservation agencies, the State Association of Conservation Districts, and the National Association of Conservation Districts also attended. Recommendations made at workshops were considered in developing plans to implement the Act.

RCA National Manual

The next major RCA activity was the development of a national manual to provide instructions for implementing the Act. The Soil Conservation

Service prepared the manual in cooperation with conservation districts and state soil and water conservation agencies. Representatives from the national offices of other USDA agencies and the National Association of Conservation Districts (NACD) helped develop the manual. On March 7, 1978, SCS held a meeting with the Natural Resources Council of America to solicit their views. The Environmental Protection Agency, General Accounting Office, Office of Management and Budget, and the Department of the Interior also helped prepare the manual.

The RCA National Manual was designed primarily for use at the field and state levels. It was used in initiating public participation, collecting data for the Appraisal, and evaluating programs.

Participation at the Local Level

The public meeting was selected as the primary technique used to enlist public participation. The main purpose of the first series of public meetings was to obtain the views of the public regarding soil and water conservation concerns and problems and to identify potential solutions. During 1978, more than 164,000 people attended 9,000 state and local meetings where RCA was explained and discussed. These meetings were held throughout the country in virtually all conservation districts. The meeting format was flexible and was tailored to the local situation. Groups representing wide ranges of interests attended these meetings.

The following tabulation shows the type of group and the number of times it was represented at a meeting:

Conservation Districts	9,853
Federal agencies (non-SCS)	7,960
State agencies	7,957
County government	6,404
General farm organizations	4,829
Citizen groups	3,792
Special interest groups	3,656
Education and youth	3,508
Conservation and environment	3,478
Other government	3,180
City government	2,985
Special district	1,682
Other groups	10,750
Total	70,034

After the public meetings, the local SCS representative completed a worksheet for each combination of SCS field office, conservation district, and county. This worksheet listed 21 resource concerns. Each concern was rated as a major concern, a minor concern, or no concern, based on the best estimate of the views expressed at the public meetings. A total of 3,485 worksheets were completed.

The following tabulation lists the resource concerns and the total number of responses indicating that a resource was a major concern:

Resource concerns	Number of responses
Soil erosion	2,994
Food and fiber production	2,443
Land use	2,163
Water supply	2,042
Water quality	1,606
Socio-political factors	1,438
Flooding	1,262
Irrigation	1,244
Rural development	1,234
Prime, unique, and important farmland	1,202
Drainage	1,042
Recreation	1,031
Forestry	1,027
Wildlife habitat	933
Land disposal of organic waste	931
Fish habitat	568
Other	537
Mining	452
Environment	430
Wetlands	303
Air quality	300

Figures 13-1 through 13-21 at the end of this chapter show, for each state, the percentage of responses indicating that a particular resource was a major concern. The SCS state conservationists have maintained a record of their state and local public participation activities. The resource concerns that were considered major varied considerably from state to state. To show this variation, table 13-1 lists the concerns in order of the number of responses within each state. For example, irrigation, code 6, ranks within the top five priorities for Florida, Georgia, and the western states but ranks much lower in most of the rest of the country. In contrast, land use, code 2, was indicated as a major concern on enough worksheets that it ranked within the top three priorities in most states.

Participation at the National Level

In September 1978, public meetings were held at five locations throughout the country to solicit the views of the public on national soil and water conservation issues. These meetings were held in Washington, D.C.; Arlington, Tex.; Oakland, Calif.; Atlanta, Ga; and Schiller Park, Ill.

Table 13-1.--How the public in each state ranked their resource concerns

Resource concern code
1. Food & fiber production
2. Land use
3. Flooding
4. Wetlands
5. Prime, unique, and important farmland
6. Irrigation
7. Water supply
8. Soil erosion
9. Mining
10. Land disposal of organic waste
11. Recreation
12. Wildlife habitat
13. Fish habitat
14. Forestry
15. Water quality
16. Air quality
17. Rural development
18. Environmental
19. Socio-political
20. Other
21. Drainage

	Most responses																				Least responses
U.S. or total	8	1	2	7	15	19	3	6	17	5	21	11	14	12	10	13	20	9	18	4	16
Alabama	8	14	3	11	21	1	17	2	7	5	6	9	15	12	19	10	20	18	13	4	16
Alaska	19	2	5	17	1	7	10	11	13	14	15	6	8	9	12	16	18	3	4	21	20
Arizona	6	1	7	11	3	8	19	15	2	12	17	5	10	18	13	20	9	21	16	4	14
Arkansas	8	1	7	3	15	11	14	6	21	2	12	20	17	13	19	5	9	10	18	4	16
California	6	8	7	2	19	1	3	12	11	5	15	17	18	20	10	13	16	14	4	9	21
Caribbean Area	8	14	7	2	15	3	17	1	6	5	9	21	11	19	12	13	4	18	16	10	20
Colorado	8	7	1	6	2	19	17	11	12	15	9	3	5	10	13	16	18	20	14	4	21
Connecticut	2	5	10	1	7	15	4	19	8	18	13	16	17	11	12	3	6	14	9	20	21
Delaware	2	5	8	21	1	3	6	10	17	7	13	15	16	4	9	11	12	14	18	19	20
Florida	6	2	21	7	5	15	1	11	17	19	3	8	12	4	14	9	10	20	13	16	18
Georgia	8	2	7	1	6	14	15	17	21	3	5	11	10	12	13	16	20	4	18	9	19
Hawaii	1	6	7	17	2	5	3	8	19	11	14	12	18	13	21	15	4	10	16	20	9
Idaho	1	8	2	6	7	5	11	19	17	15	12	20	13	10	14	18	3	21	16	9	4
Illinois	8	2	1	7	5	15	19	21	3	12	17	14	13	9	10	20	11	18	4	6	16
Indiana	8	2	21	1	15	14	5	17	3	19	7	10	11	12	9	13	18	6	16	20	4
Iowa	8	15	2	1	19	5	7	17	18	12	21	14	13	3	16	10	4	6	11	9	20
Kansas	8	7	1	6	15	3	2	12	17	19	21	11	5	10	20	9	13	16	18	14	4
Kentucky	8	15	2	7	1	5	10	21	14	20	3	9	19	17	12	11	18	16	6	13	4
Louisiana	8	1	21	15	3	2	10	11	7	5	12	13	17	14	19	4	18	16	20	9	6
Maine	1	2	8	10	19	5	17	15	14	7	21	4	11	20	3	13	18	6	9	12	16
Maryland	8	1	2	5	7	15	17	10	19	21	3	13	14	11	20	4	6	9	18	12	16
Massachusetts	1	2	7	10	5	8	19	11	4	12	13	3	15	14	18	6	17	16	9	21	20
Michigan	1	2	8	15	14	21	10	19	11	5	6	17	7	13	4	12	20	9	3	18	16
Minnesota	8	1	2	15	19	17	21	12	7	5	4	3	10	14	6	11	13	18	9	20	16
Mississippi	8	3	21	2	14	1	11	10	15	17	9	7	12	19	13	5	6	4	18	20	16
Missouri	8	1	7	2	3	15	12	10	19	5	17	6	14	11	13	9	20	21	18	16	4
Montana	1	6	8	20	7	2	17	19	15	5	11	3	12	14	9	13	18	10	16	21	4
Nebraska	1	2	7	19	15	3	11	10	8	17	5	6	12	16	4	13	18	20	9	21	14
Nevada	6	7	2	1	8	15	5	13	19	3	17	12	11	16	9	10	18	21	14	4	20
New Hampshire	1	2	5	4	12	13	17	7	18	3	15	19	21	8	10	11	14	9	16	6	20

Table 13-1.--How the public in each state ranked their resource concerns (continued)

		Most responses																				Least responses
Note:	New Jersey	2	10	7	19	3	21	1	15	8	4	5	6	11	18	13	16	20	14	17	9	12
Within each	New Mexico	1	8	7	19	2	6	17	11	3	15	20	5	12	9	10	16	13	18	14	21	4
state, resource	New York	8	1	2	15	21	10	7	5	19	3	17	11	13	4	6	12	14	18	20	16	9
concerns are	North Carolina	8	1	14	2	15	7	11	17	5	10	21	19	12	13	6	3	16	20	18	9	4
ranked in	North Dakota	8	15	7	1	21	3	12	20	2	4	6	9	11	19	5	18	10	14	16	13	17
descending order	Ohio	8	1	2	21	5	14	15	7	19	10	17	12	3	9	18	13	20	11	4	6	16
from left to right.	Oklahoma	8	1	7	3	2	10	6	19	17	15	5	11	12	14	21	9	20	13	16	18	4
The basis for the	Oregon	8	1	14	21	6	7	3	20	5	15	12	18	10	19	17	2	4	13	9	11	16
ranking was the	Pennsylvania	8	2	7	5	15	19	1	17	3	10	9	11	13	14	21	12	18	6	20	16	4
number of public	Rhode Island	2	19	1	5	7	14	17	8	13	15	9	10	11	4	20	3	6	12	16	18	21
responses showing	South Carolina	8	1	2	21	14	6	15	19	7	3	5	10	12	11	17	20	4	9	16	18	13
that a particular	South Dakota	8	1	7	6	2	17	19	12	15	10	20	11	4	18	9	3	5	13	14	16	21
resource concern	Tennessee	8	1	3	2	15	14	10	21	5	7	11	19	17	9	12	13	16	18	6	20	4
was "major."	Texas	8	1	7	6	3	2	17	11	12	19	15	10	20	14	5	21	9	16	13	18	4
	Utah	7	1	2	6	8	11	19	5	17	3	10	12	15	13	21	4	16	20	18	9	14
	Vermont	1	15	19	2	5	17	21	10	14	7	8	13	4	11	18	12	3	6	9	16	20
	Virginia	8	2	7	1	3	14	5	19	15	21	17	11	10	13	12	6	9	18	16	4	20
	Washington	8	2	5	6	1	7	17	19	15	21	11	14	12	13	10	3	18	16	20	4	9
	West Virginia	8	2	1	7	17	15	5	19	9	11	14	10	3	13	21	20	16	6	12	18	4
	Wisconsin	8	2	15	1	5	19	4	14	10	17	21	11	3	12	13	7	6	20	16	18	9
	Wyoming	7	6	1	2	8	20	11	17	19	12	15	5	13	21	18	3	9	10	14	16	4

These five meetings were announced by a USDA news release dated August 14, 1978, and a notice in the Federal Register dated August 17, 1978 (43 FR 36495). In addition, SCS sent letters announcing the five national meetings and inviting participation and comment to 1,200 individuals, most of whom represent state, regional, or national organizations or groups. This letter was signed jointly by the Administrator of the Soil Conservation Service, USDA, and the President of the National Association of Conservation Districts.

These national meetings allowed the 94 registrants to offer public comments. About one-third of the comments received during these meetings dealt with procedural items, that is, how the appraisal would or should be carried out. Another one-third dealt with socio-political, economic, and educational concerns. The remaining comments and statements emphasized environmental issues, water quality, soil erosion, and flooding. Written comments received at the meetings dealt with many of these same concerns.

The following topics were discussed during the five national RCA meetings held in September 1978:

Resource problems and needs:
- Water conservation
- Visual resources
- Natural resources
- Sedimentation
- Drought
- Insect infestation
- Communications
- Rural flooding
- Urban flooding
- Water quality
- Education
- Urban areas
- Population growth

Institutional arrangements:
- Inadequate funding
- Conservation districts
- Federal programs
- RCA process
- Research

Attitudes:
- Citizen attitudes on taxes
- Freedom of action for a landowner/ land user
- Voluntary approach, incentives

As a result of the notices of the national meetings, letters were received from 28 individuals and groups. The 12 resource concerns discussed in these letters were:

Land use
Flooding
Wetlands
Water supply
Soil erosion
Environment
Mining
Land disposal of organic waste
Recreation
Fish and wildlife
Forestry
Socio-political factors

The SCS Washington Office is maintaining a public record of the national public participation activities.

Issue Papers

SCS identified thirteen national policy issues for study as part of the work for the 1980 Program and Statement of Policy required by the Act. Study groups explored these policy issues and prepared impact papers. The members of the study groups were selected from agencies within and outside USDA and from interest groups. Agencies and groups outside USDA that were represented were:

American Farm Bureau Federation
Congressional Research Service
Environmental Policy Center
National Association of Conservation Districts
National Farmers Union
National Wildlife Federation
Resources for the Future
Council on Environmental Quality
Environmental Protection Agency
Fish and Wildlife Service
National Oceanographic and Atmospheric Administration

These issue papers provide data that USDA can use to explore potential problems and alternative strategies to solve soil and water conservation problems.

The RCA Process

In October 1978, the Secretary of Agriculture expanded RCA planning and implementation activities to include all USDA soil and water conservation programs and reestablished an interagency coordinating committee to guide the overall RCA effort. Members of the committee are from the Agricultural Stabilization and Conservation Service (ASCS); Economics, Statistics, and Cooperatives Service (ESCS); Farmers Home Administration (FmHA); Forest Service (FS); Rural Electrification Administration (REA); Soil Conservation Service (SCS); Science and Education Administration (SEA); Office of Management and Budget (OMB); Council on Environmental Quality (CEQ); and the USDA Secretary's Office. A notice of the formation of the coordinating committee and an invitation to the public to attend future meetings as observers were issued in the Federal Register on January 3, 1979 (44 FR 927). Some interest groups have attended these meetings.

The coordinating committee developed an overall strategy to guide the RCA process. This strategy, detailed in the document "RCA Process," was approved by the coordinating committee on February 2, 1979. The availability of the publication "RCA Process" was announced in the Federal Register on February 20, 1979 (44 FR 10407).

A public briefing for 80 national organizations was held on January 19, 1979, in Washington, D.C., to inform the public of the status and progress of RCA activities. On January 26, 1979, and January 29, 1979, similar briefings were held for the SEA staff and the FS regional staff.

At the annual convention of the National Association of Conservation Districts, February 11-14, 1979, in Washington, D.C., the status of RCA was explained to the NACD members and the administrative officers of state conservation agencies.

On February 15, 1979, a briefing was held in Washington, D.C., for ASCS, ESCS, REA, and SCS Washington personnel, SCS state conservationists, state soil and water conservation agency personnel, soil conservation district officials, and interested state and national organizations. The state conservationists briefed their respective state and local soil and water conservation agency officials on the RCA process in March 1979.

The 1979 Public Participation Program calls for publication and distribution of the draft Appraisal, Program, and Policy documents in September, 1979, followed by a 60-day public review period. During this time, comments about these documents will be accepted by designated USDA offices. Full details on where the documents will be located for review, exact review period dates, and the formalities of analyzing the results will be published in the Federal Register at the time the documents are available at their designated locations.

The details of the National Public Participation Program will be explained in the RCA Program document.

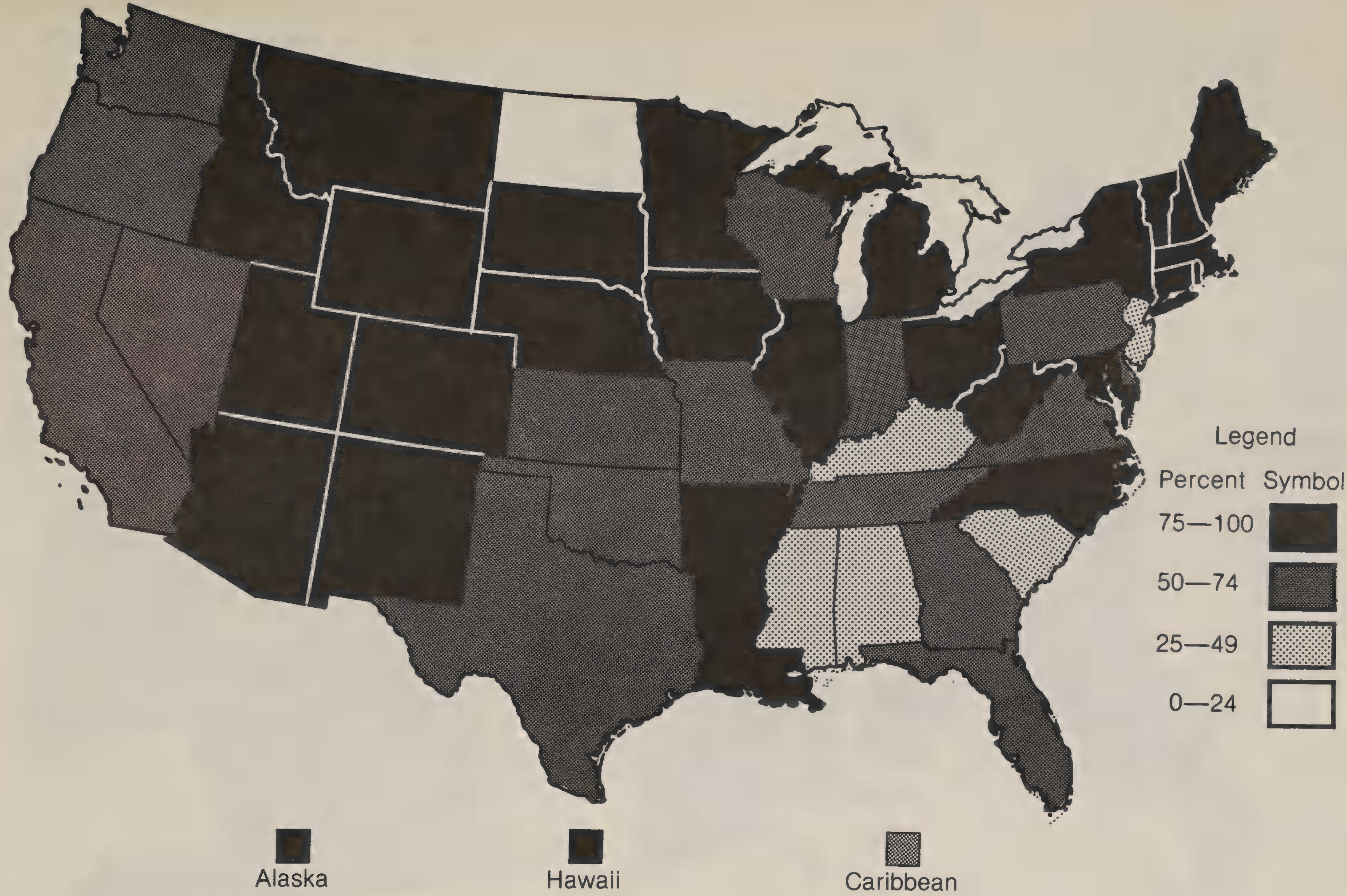

Figure 13-1.--Percentage of responses from each state indicating food and fiber production (01) as a major concern.

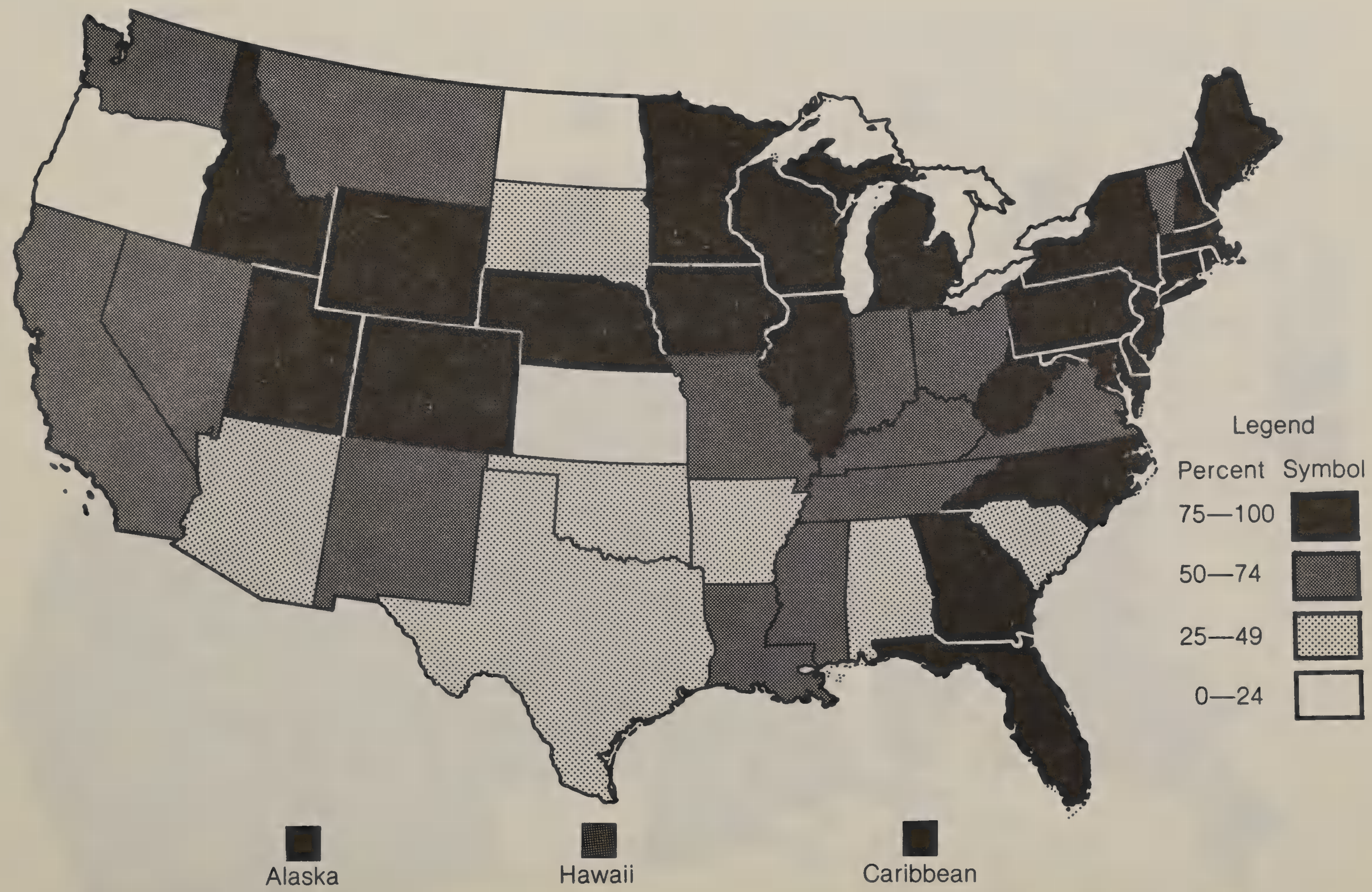

Figure 13-2.--Percentage of responses from each state indicating land use (02) as a major concern.

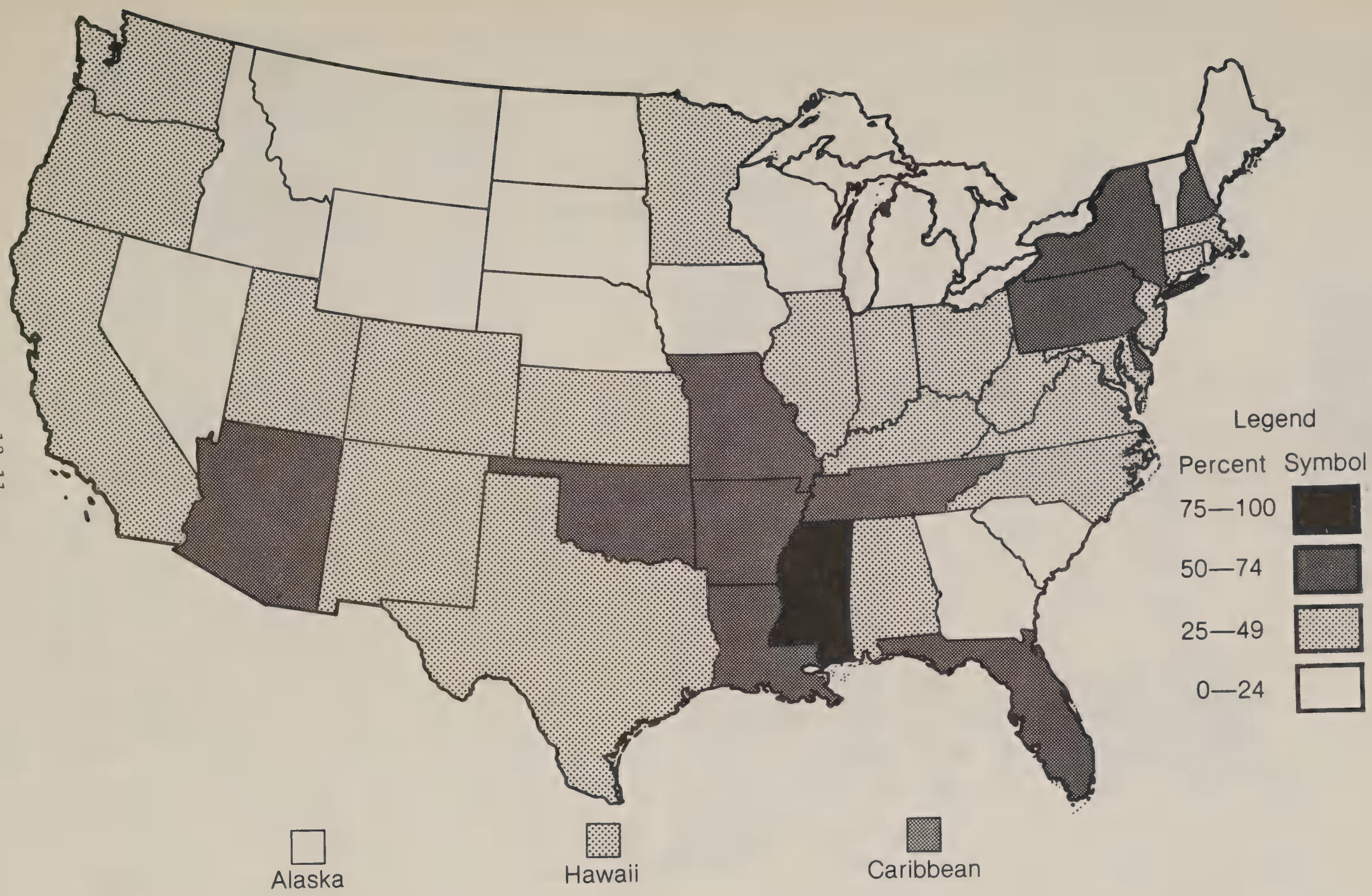

Figure 13-3.--Percentage of responses from each state indicating flooding (03) as a major concern.

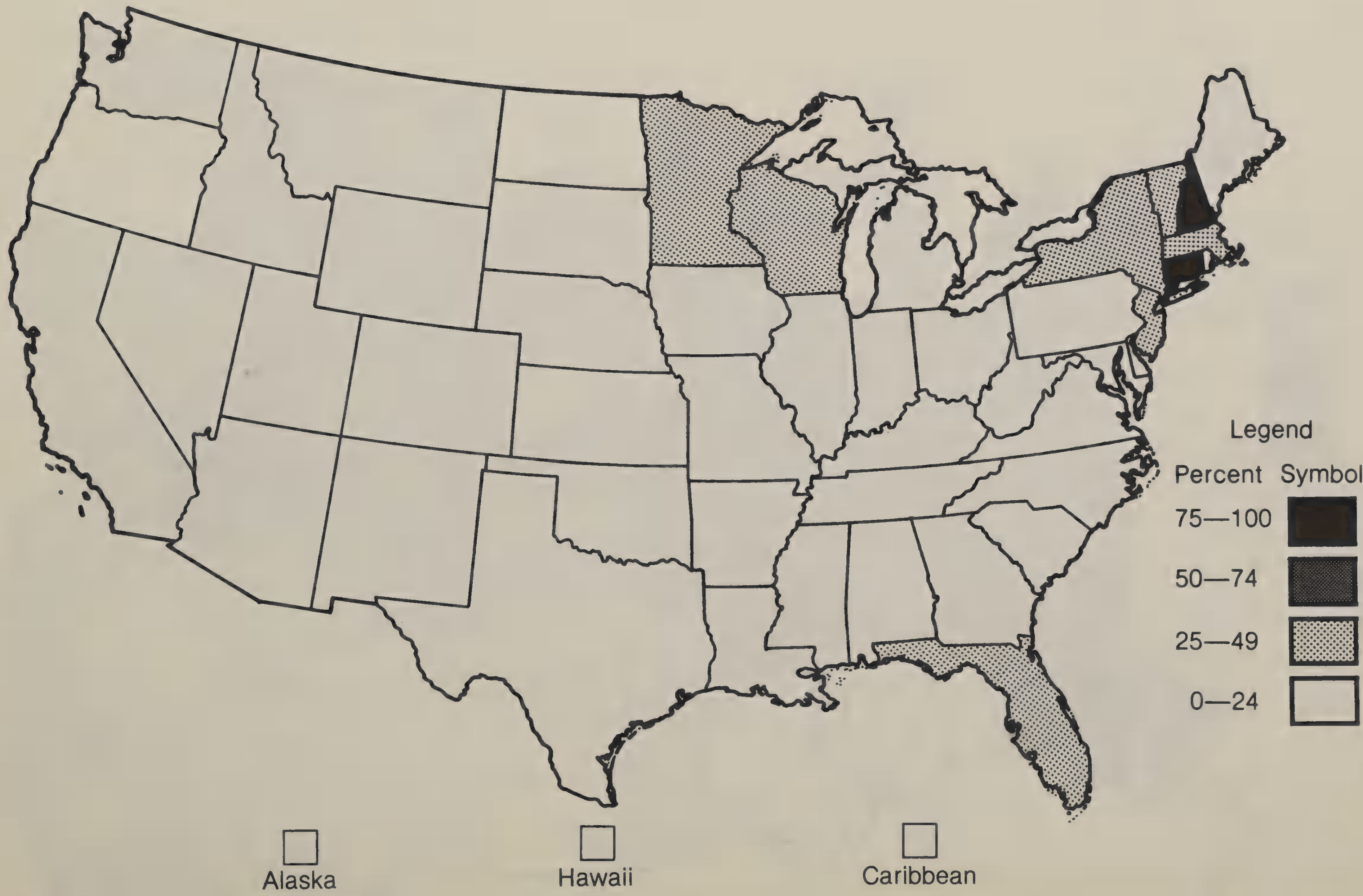

Figure 13-4.--Percentage of responses from each state indicating wetlands (04) as a major concern.

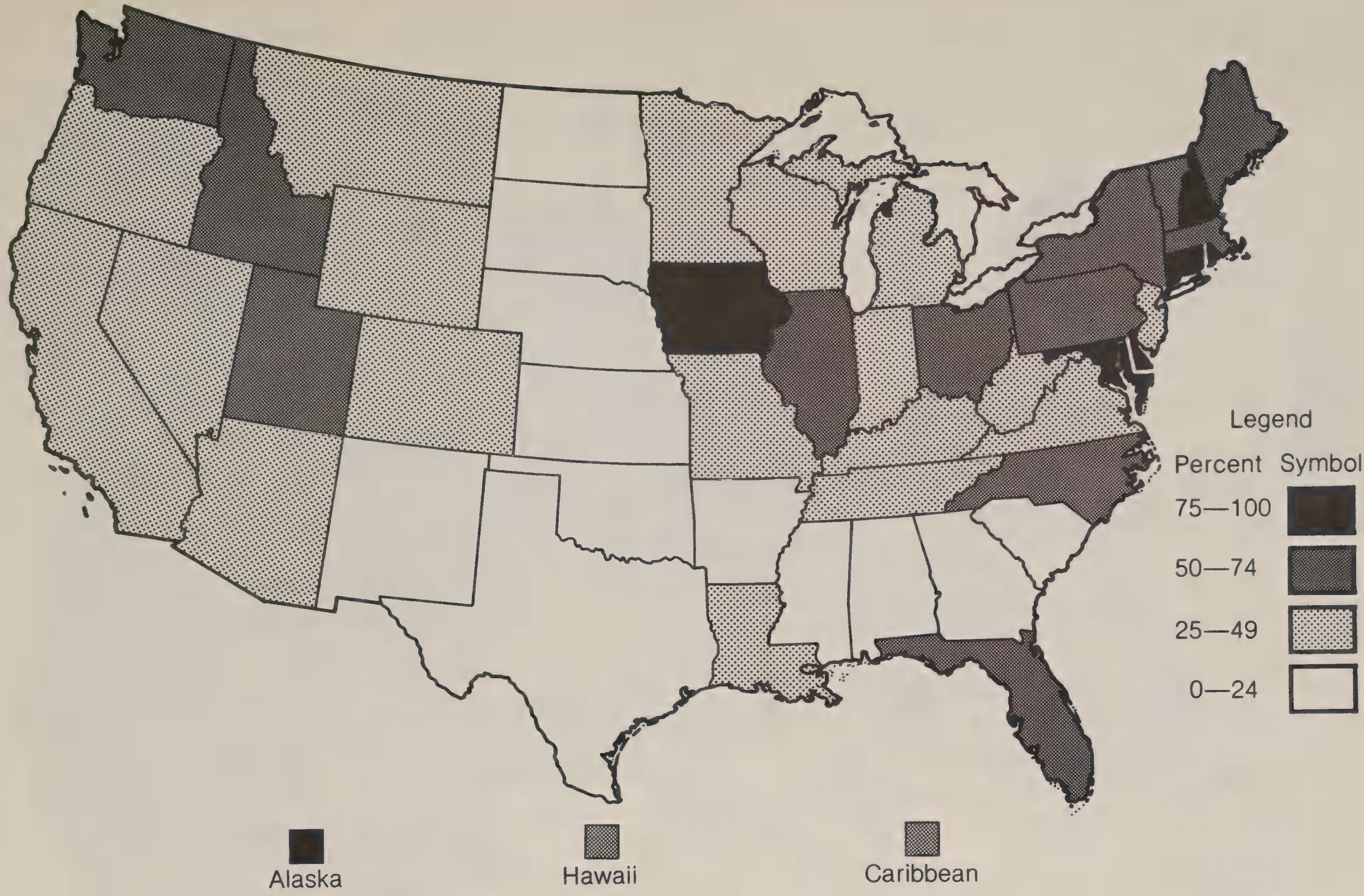

Figure 13-5.--Percentage of responses from each state indicating prime, unique, and important land (05) as a major concern.

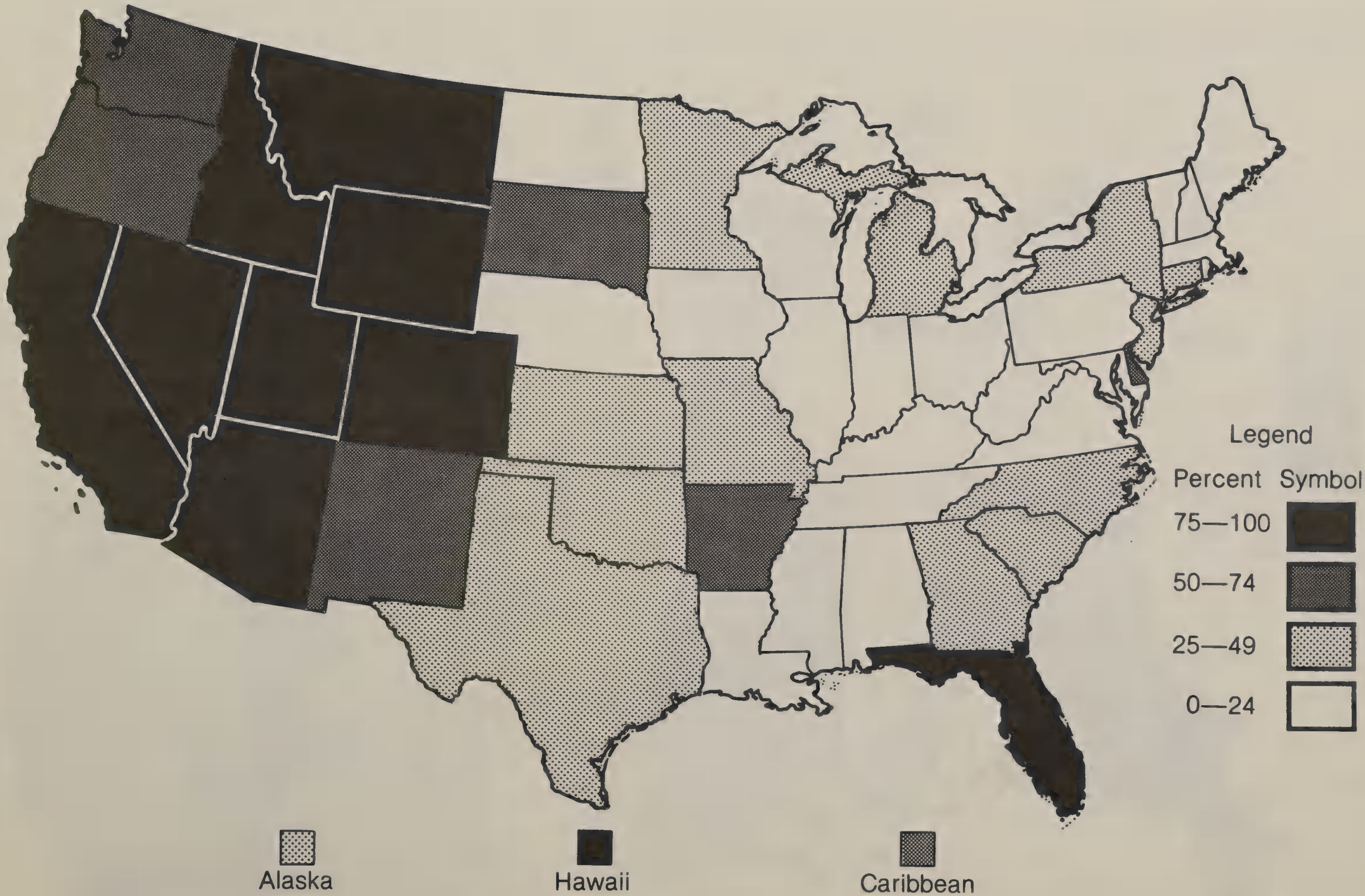

Figure 13-6.--Percentage of responses from each state indicating irrigation (06) as a major concern.

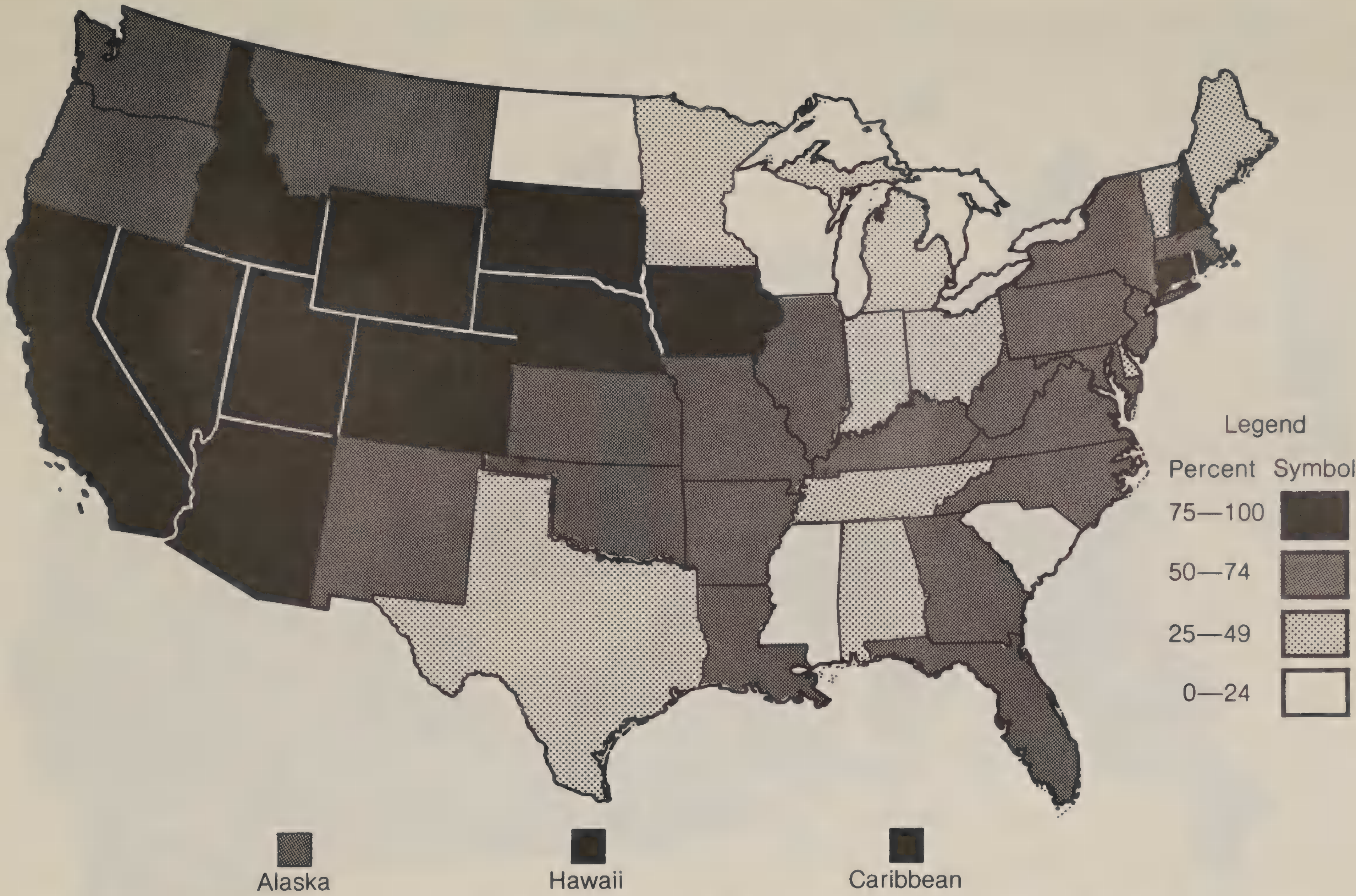

Figure 13-7.--Percentage of responses from each state indicating water supply (07) as a major concern.

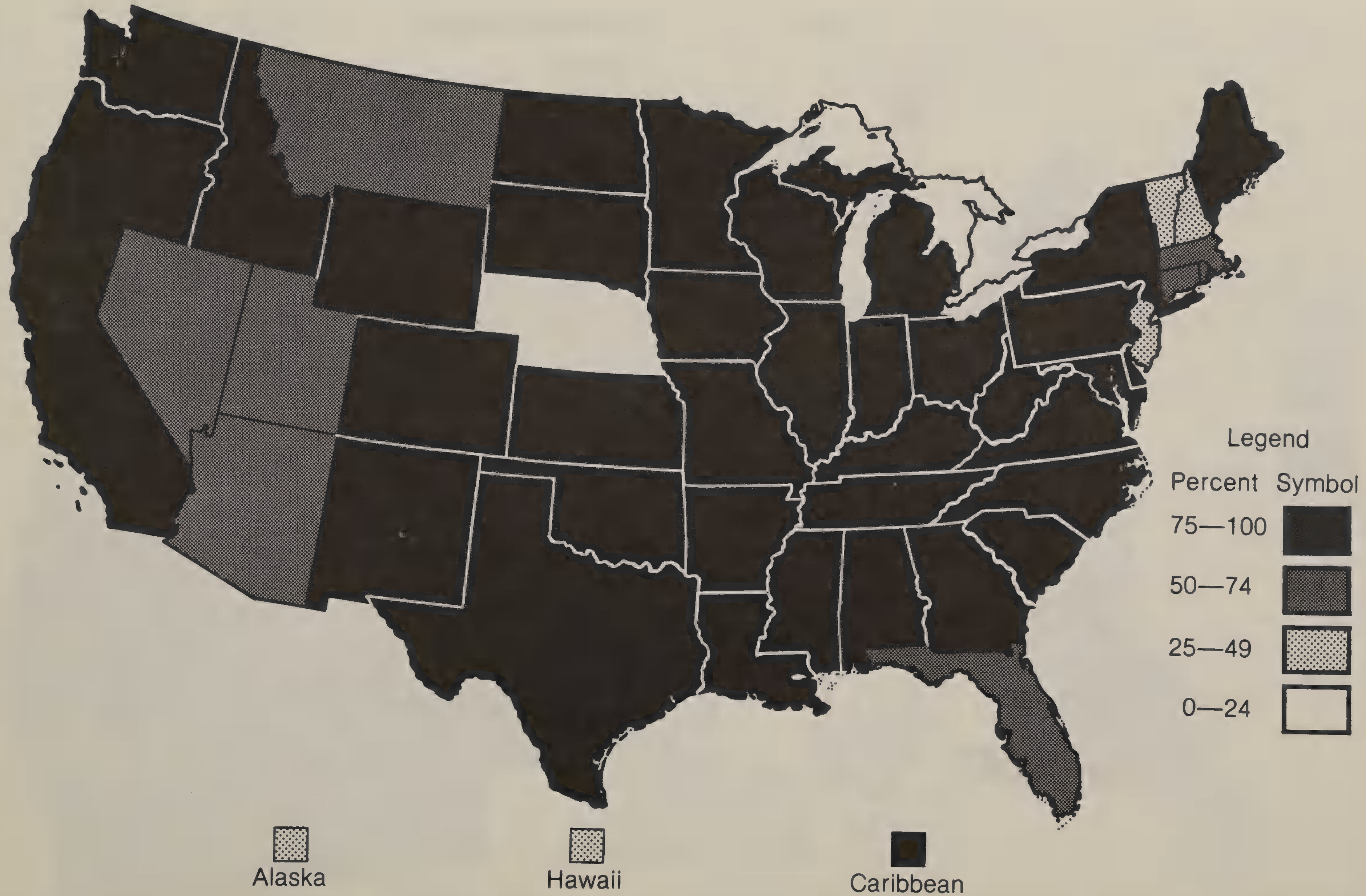

Figure 13-8.--Percentage of responses from each state indicating soil erosion (08) as a major concern.

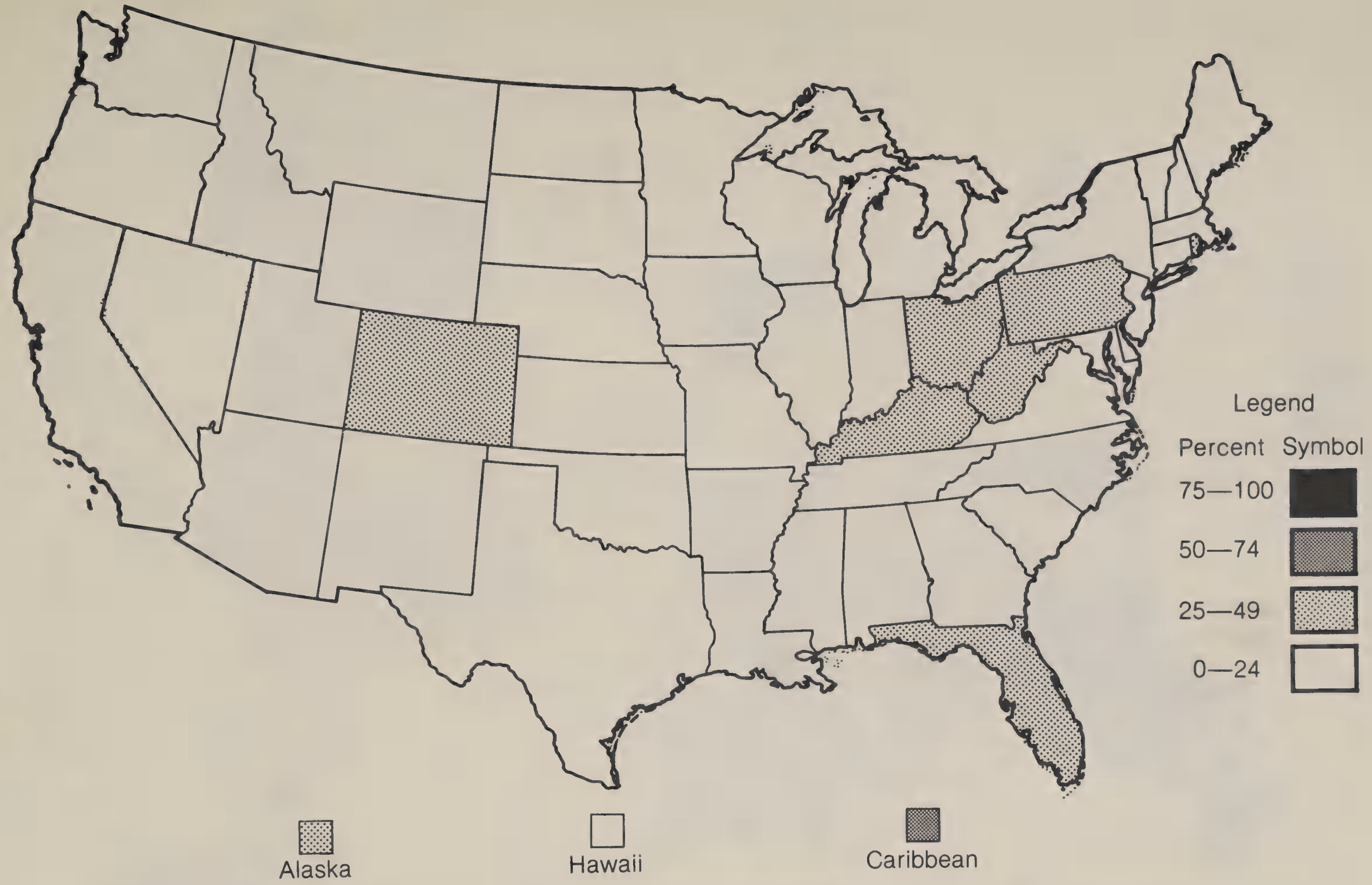

Figure 13-9.--Percentage of responses from each state indicating mining (09) as a major concern.

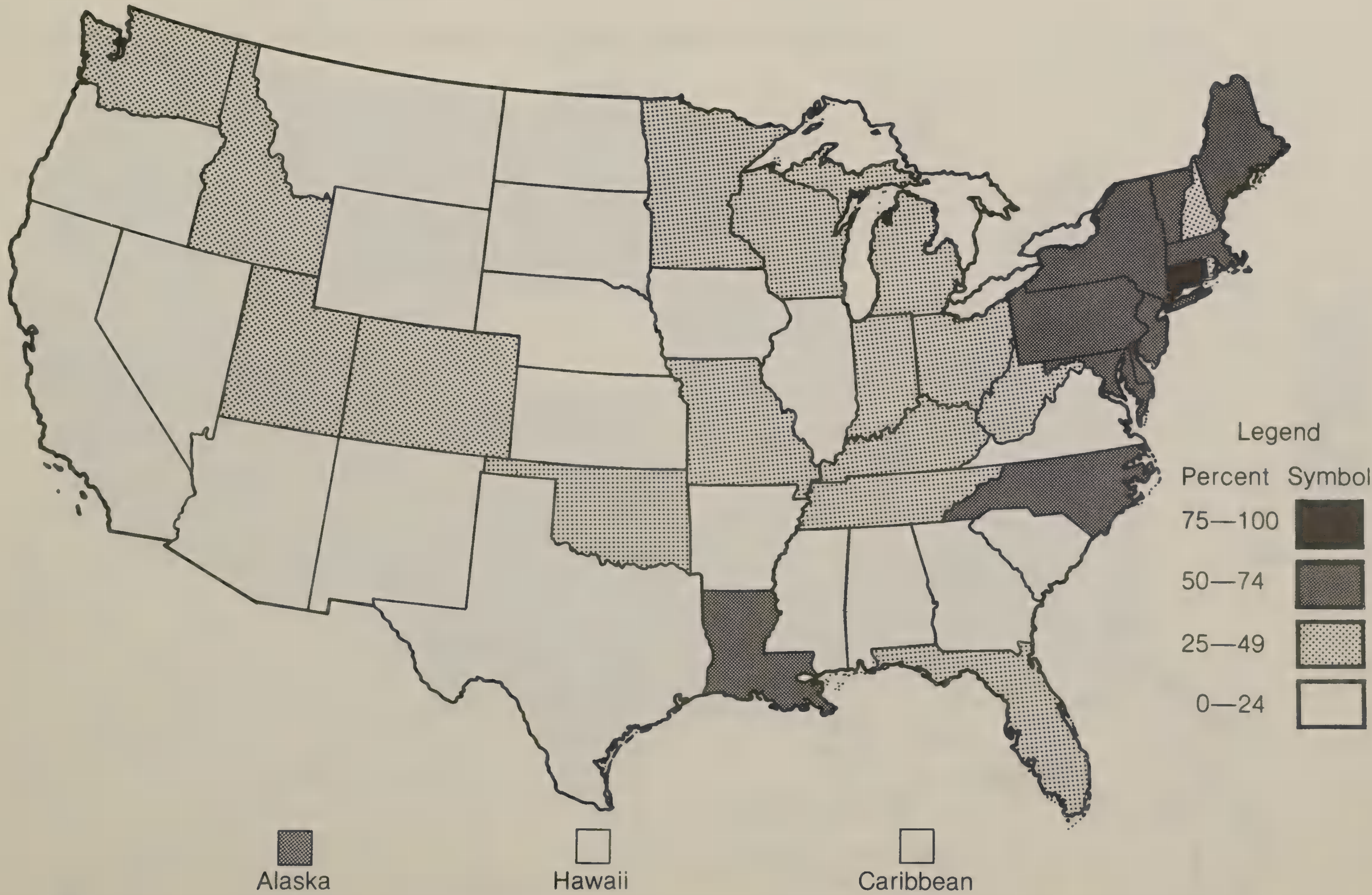

Figure 13-10.--Percentage of responses from each state indicating land disposal and organic waste (10) as a major concern.

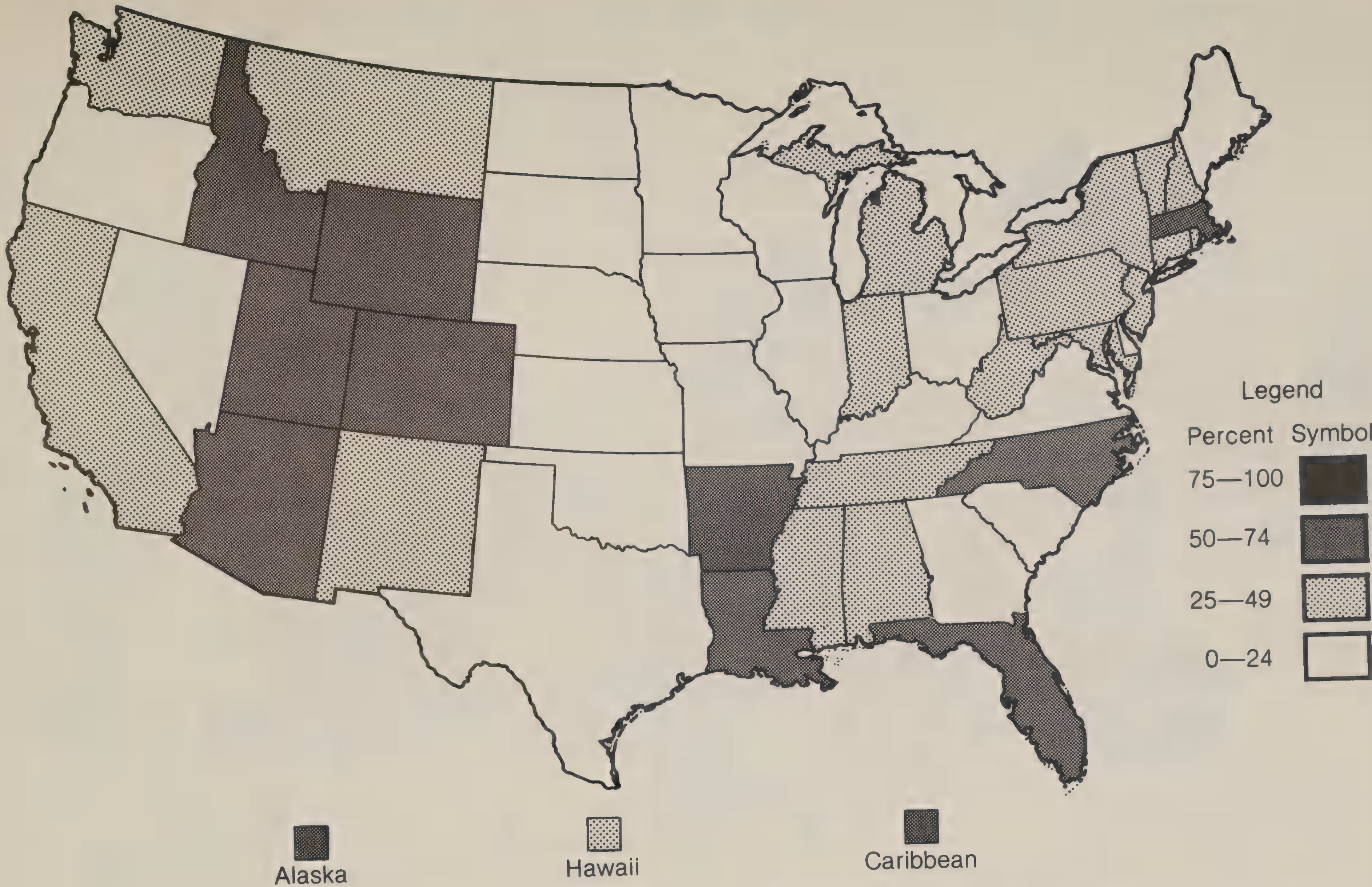

Figure 13-11.--Percentage of responses from each state indicating recreation (11) as a major concern.

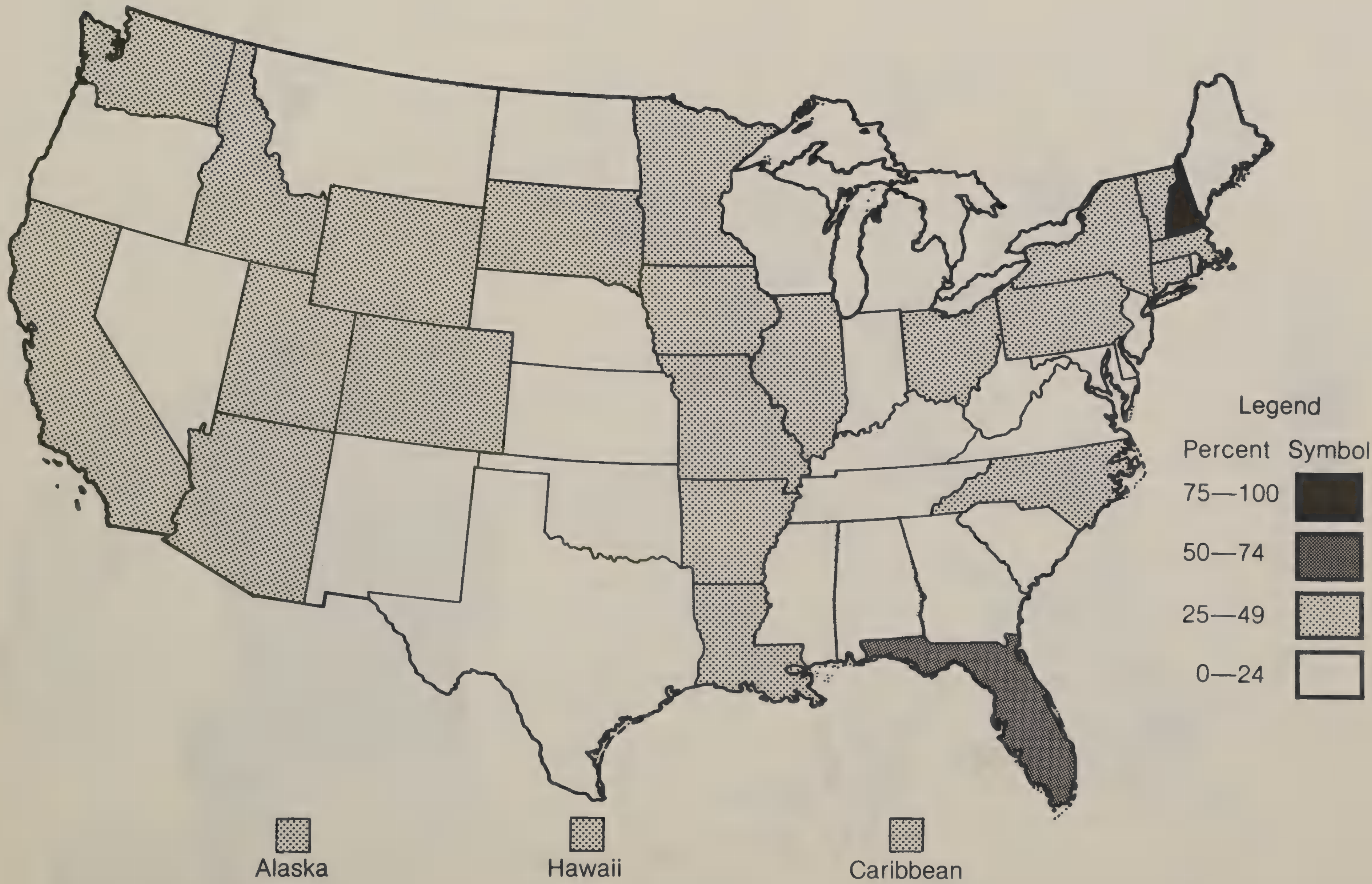

Figure 13-12.--Percentage of responses from each state indicating wildlife habitat (12) as a major concern.

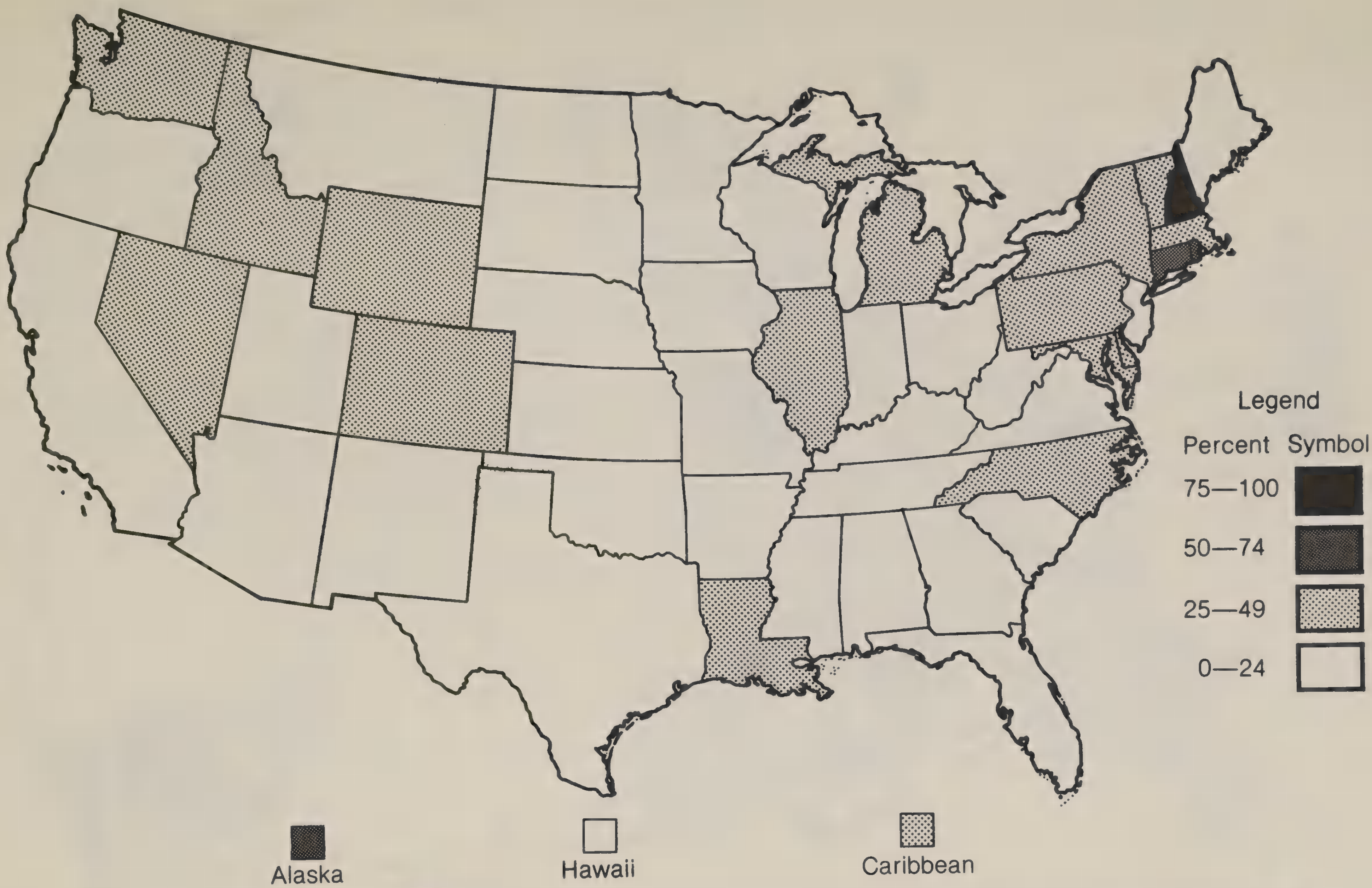

Figure 13-13.--Percentage of responses from each state indicating fish habitat (13) as a major concern.

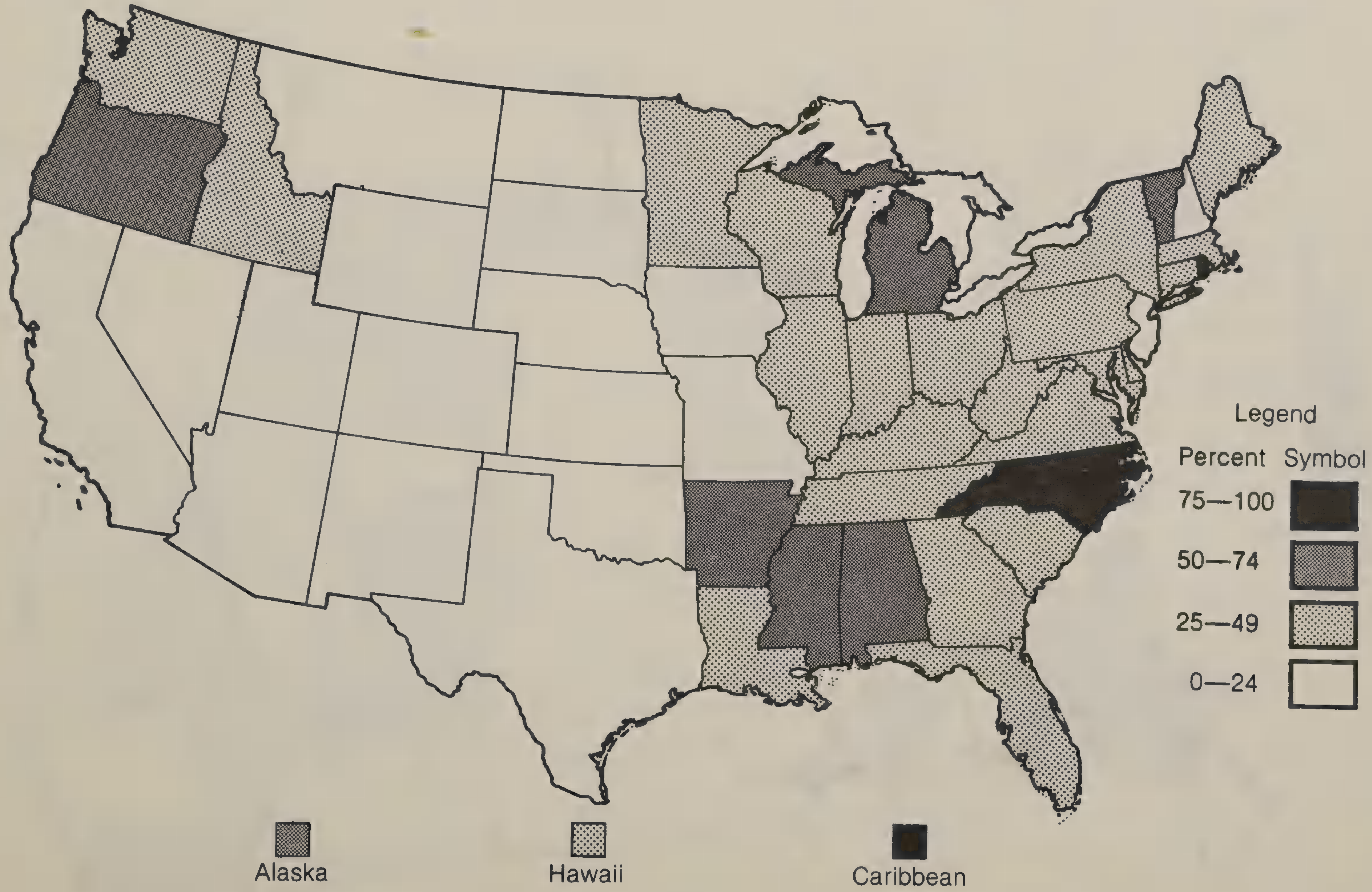

Figure 13-14.--Percentage of responses from each state indicating forestry (14) as a major concern.

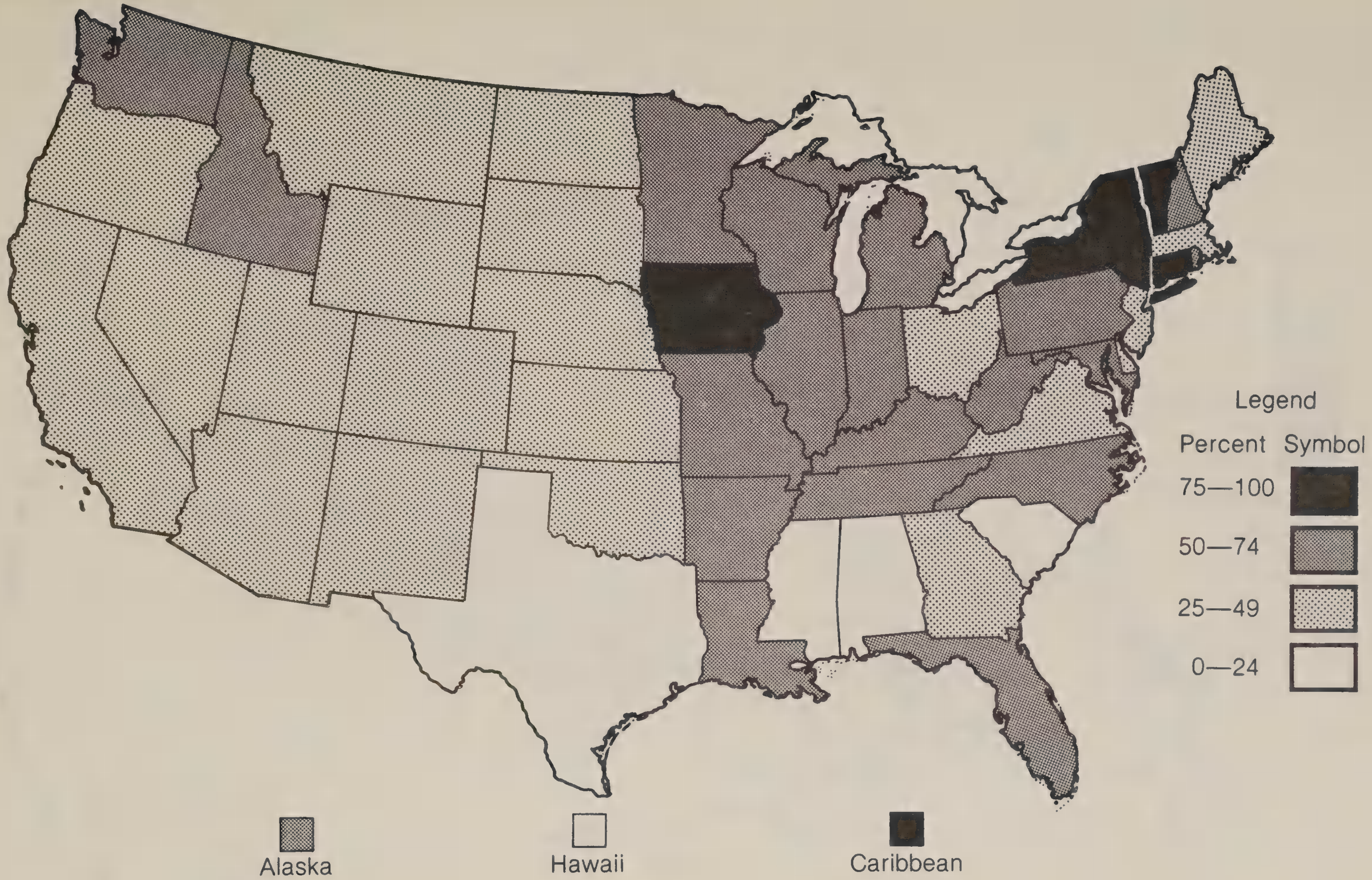

Figure 13-15.--Percentage of responses from each state indicating water quality (15) as a major concern.

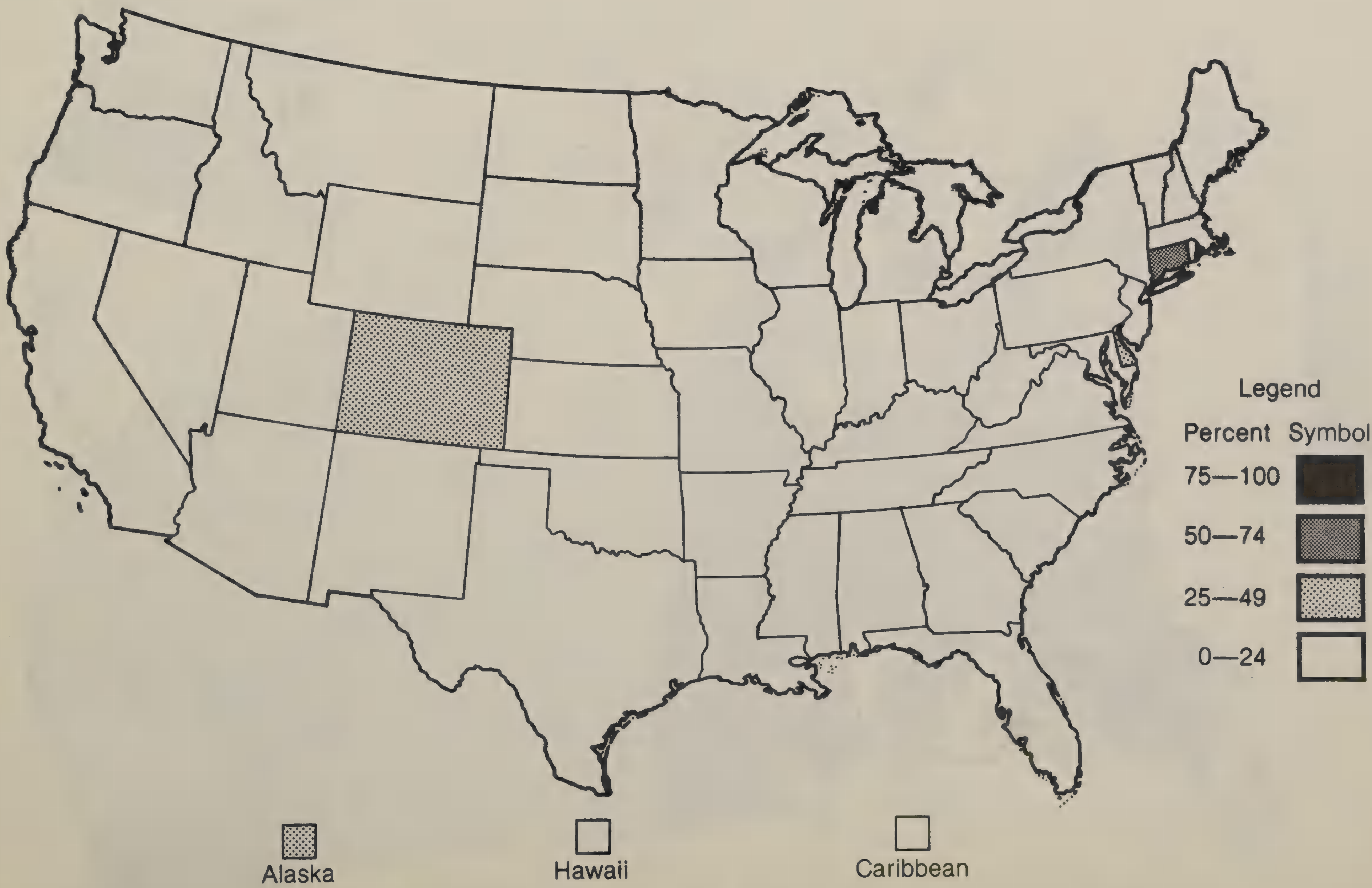

Figure 13-16.--Percentage of responses from each state indicating air quality (16) as a major concern.

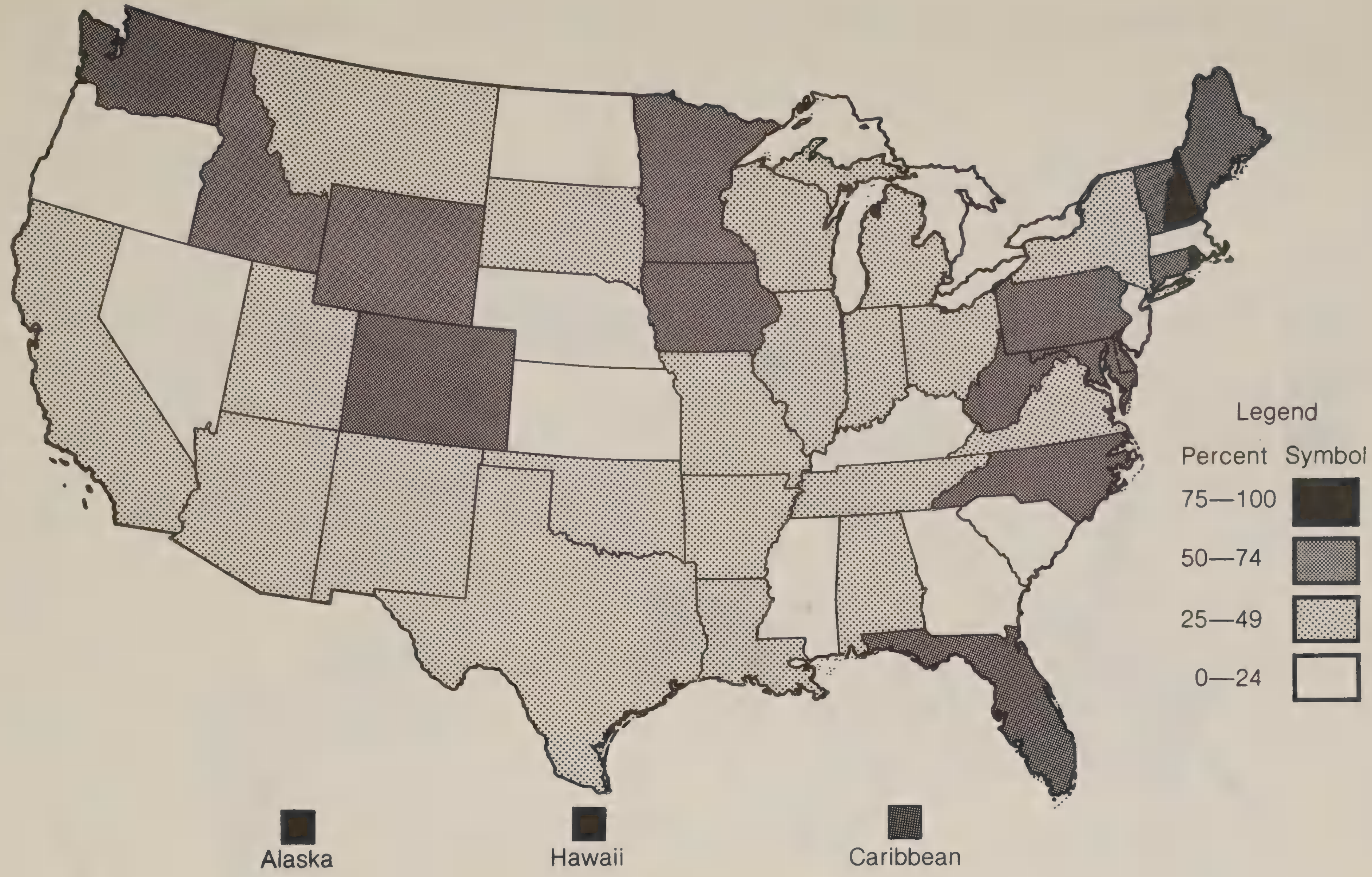

Figure 13-17.--Percentage of responses from each state indicating rural development (17) as a major concern.

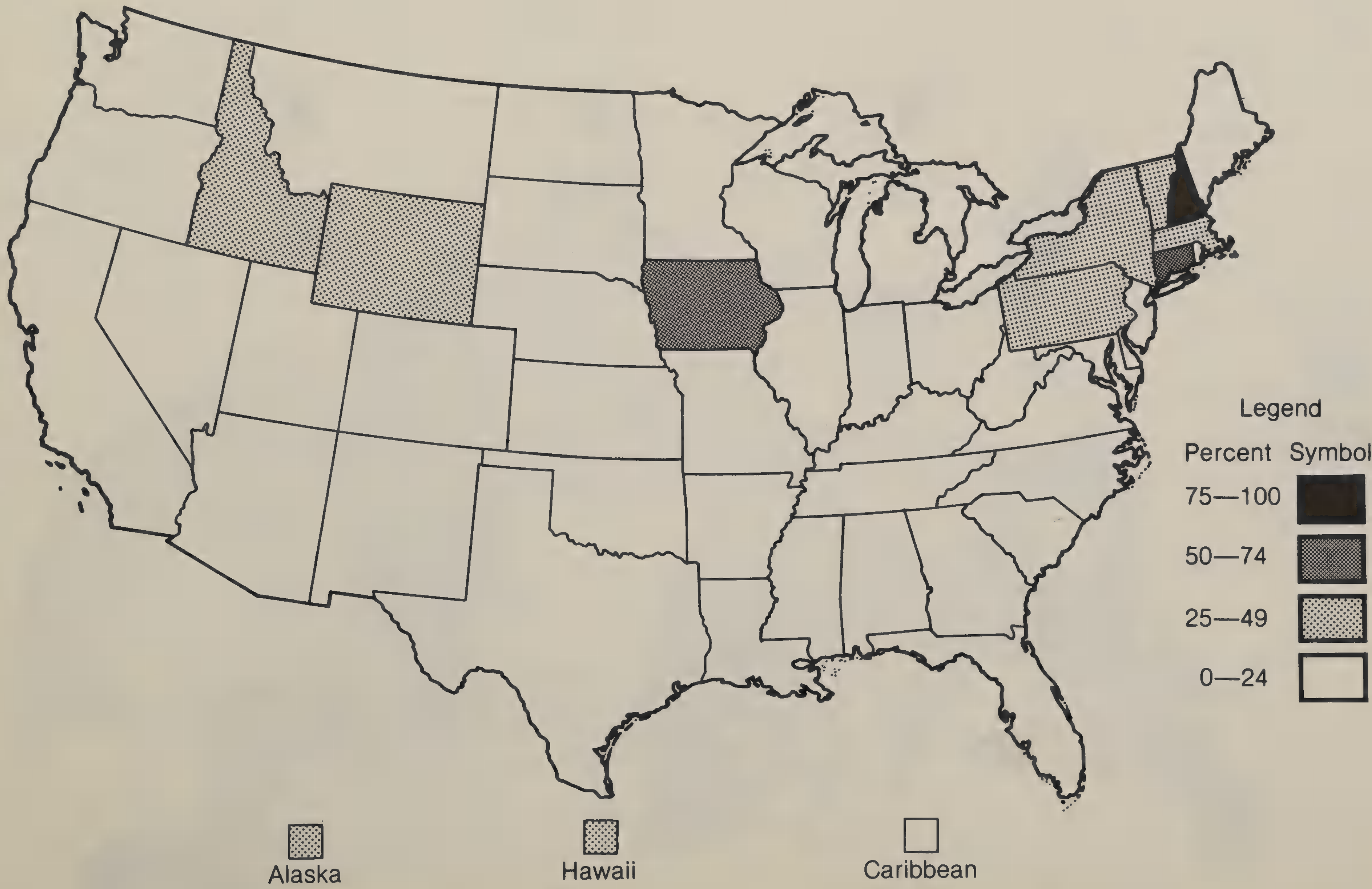

Figure 13-18.--Percentage of responses from each state indicating environment (18) as a major concern.

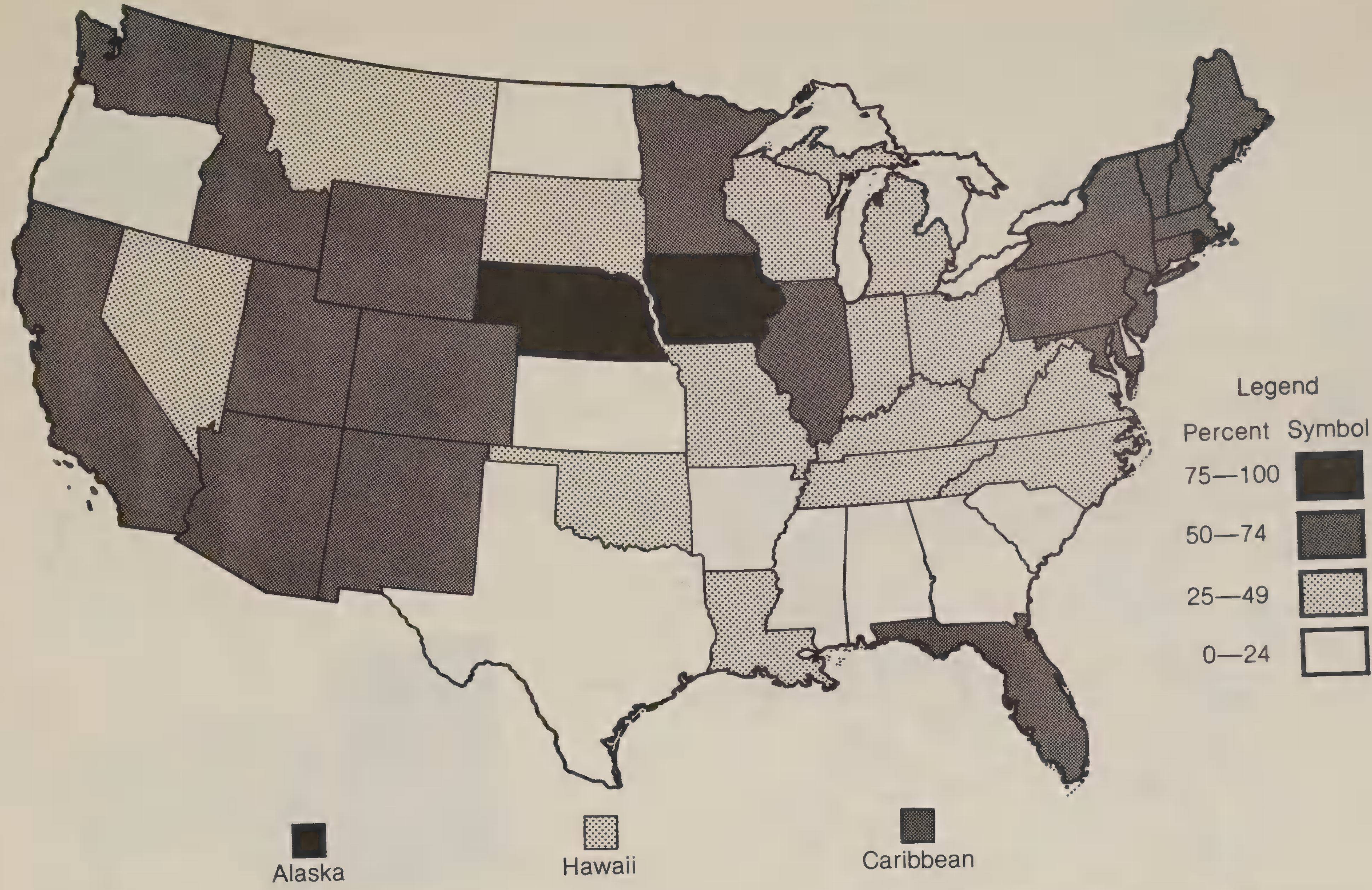

Figure 13-19.--Percentage of responses from each state indicating socio-political (19) as a major concern.

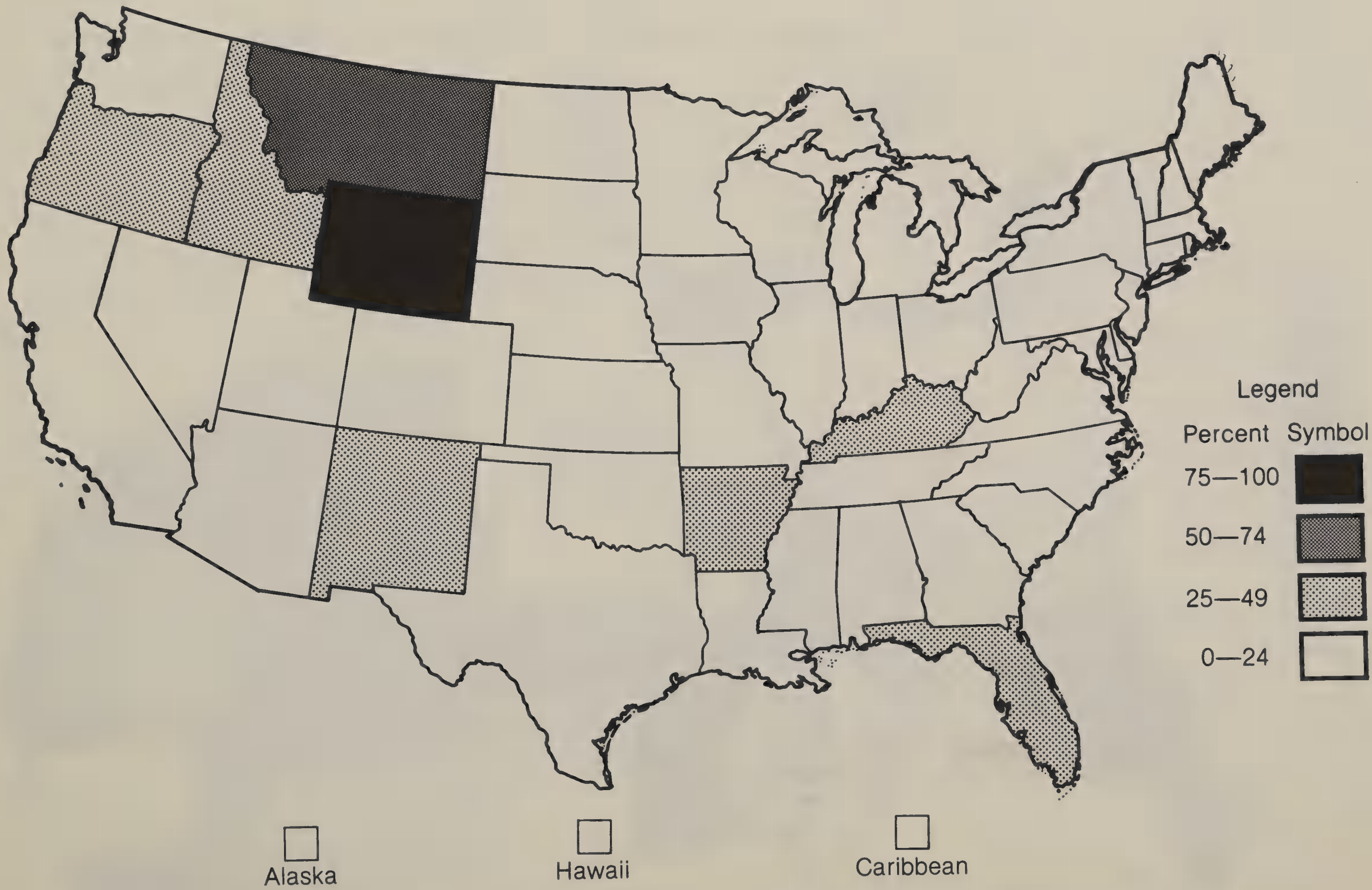

Figure 13-20.--Percentage of responses from each state indicating other (20) as a major concern.

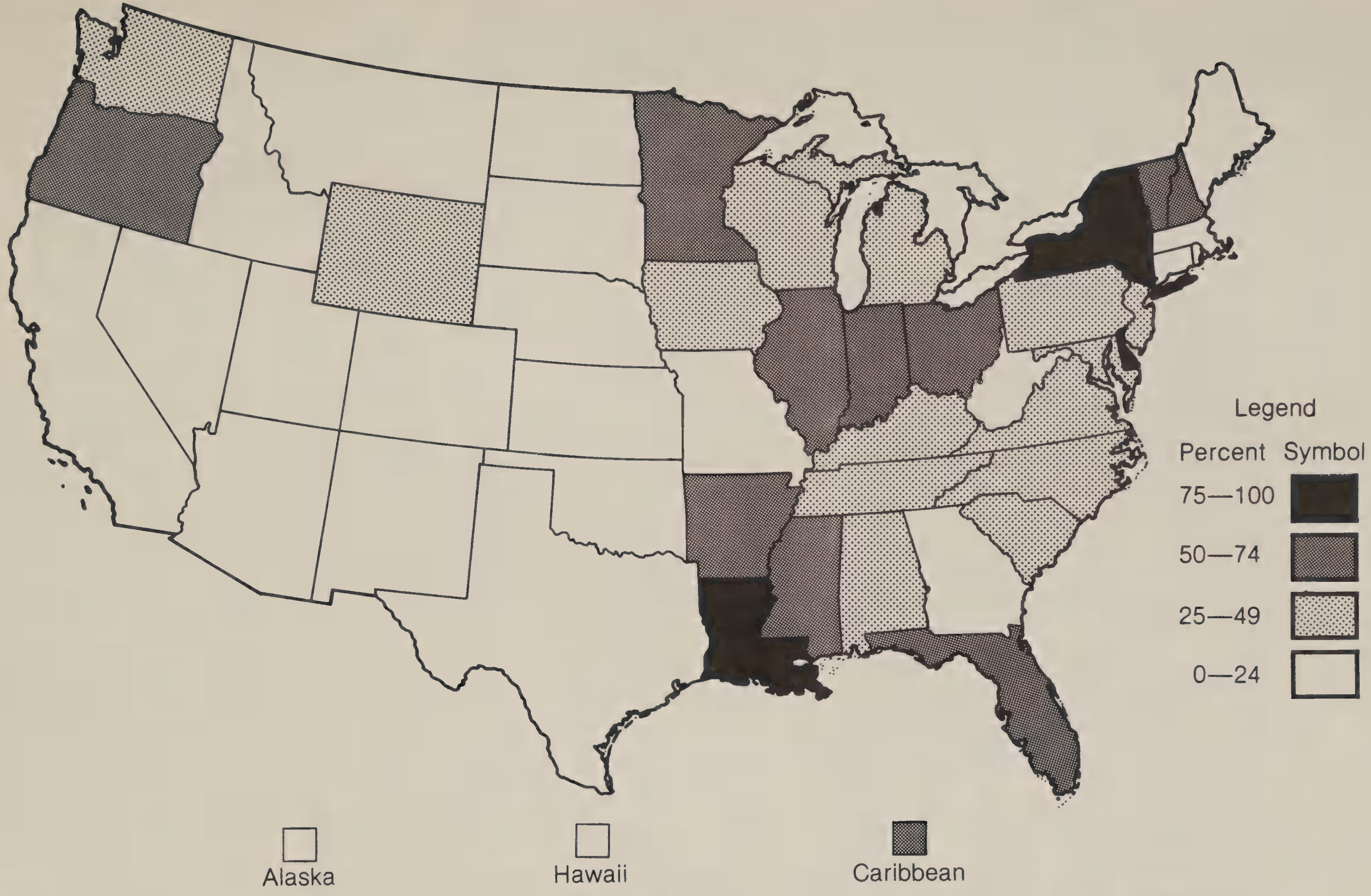

Figure 13-21.--Percentage of responses from each state indicating drainage (21) as a major concern.

Chapter 14 - The Relationship Between Public Perceptions and Available Data

The public's major resource concerns are listed in the preceding chapter. These concerns are, for the most part, supported by the resource data presented in earlier chapters of this appraisal. The public's resource concerns were divided into three groups according to the number of responses that listed a concern as major. Then they were analyzed to show the relationship between public perception and existing data. Of the 3,485 public responses, more than 2,000 identified soil erosion, food and fiber production, land use, and water supply as major concerns. These four concerns formed the first group. The next group in order of importance included concerns over water quality; socio-political factors; flooding; irrigation; rural development; prime, unique, and important farmland; drainage; recreation; and forestry. The number of responses that listed the concerns in group two as major range from a high of 1,606 for water quality to a low of 1,027 for forestry. For the remaining concerns that form the third group-- wildlife habitat, land disposal of organic waste, fish habitat, other, mining, environmental, wetlands, and air quality--fewer than 1,000 responses indicated that they were major concerns. The following discussion compares the three groups of public resource concerns with selected existing resource data.

The table at the conclusion of this chapter is a listing of selected simple correlation coefficients. SCS developed these coefficients by statistically comparing RCA Worksheet 1 responses with resource data. For correlation purposes, resource concerns were measured by determining 1) the number of worksheets from each state listing a resource concern as major and 2) the percentage of each state's total worksheets which listed that concern as major. A greater degree of correlation between the resource concerns and the resource data was obtained by using the number of responses than by using the percentages.

In statistical terms, each state was considered an "observation" in the analysis. Resource concerns were compared with the state's resource conditions as described by data from the 1977 National Resource Inventories.

The following discussion, along with the correlation coefficients, substantiates the premise that the public's perception of natural resource concerns is, for the most part, supported by existing resource data.

Soil erosion, food and fiber production, land use, and water supply were the four resource concerns that most people considered major.

Sheet and rill erosion is a serious problem in many areas according to the 1977 SCS National Resource Inventories (USDA, 1978). These inventories show that 58 percent of all cropland and 55 percent of all irrigated cropland require some type of treatment. If this concern is related to the number of acres of land in row crops where erosion control is needed, the correlation coefficient is +0.594. A correlation coefficient indicates the degree of relationship between variables. In this instance the two variables are the number of public responses expressing concern over soil erosion and the number of acres of land in row crops that have erosion

control problems. A correlation coefficient of +1 would show a direct positive relationship between the two variables. A coefficient of zero would show that the two variables have no relation to each other. A coefficient of -1 would show a direct inverse relationship.

Areas where soil erosion is of special concern include Aroostook County, Maine, which devotes approximately 950,000 acres to potato production. The average potato field there is losing soil at the rate of more than 15 tons per acre, per year. Some fields have lost as much as 1 inch of soil per year for the past several years. Soil erosion was listed as a major concern in all the public responses from Aroostook County.

Water erosion on cropland is particularly damaging in several geographical areas of the United States. The following tabulation shows the public's perception of erosion problems in areas experiencing critical levels of erosion:

Major land resource areas	Number of responses	Percentage of responses listing soil erosion as a major concern
Palouse & Nez Perce Prairies	9	100
Columbia Plateau	12	100
Southern Mississippi Valley Silty Uplands	58	100
Loess, Till, and Sandy Prairie	58	67
Central Iowa and Minnesota Till Prairies	48	77
Nebraska and Kansas Loess-Drift Hills	51	96
Iowa and Missouri Deep Loess Hills	32	47
Central High Plains	21	100
Central High Tableland	34	82

Although wind erosion is significant in other areas, the greatest damage to cropland occurs in the Great Plains. Recent data show that it is most damaging in Texas, New Mexico, and Colorado where wind erosion on cropland removes about 14.9, 11.5, and 8.9 tons of soil per acre, respectively. Public responses listed wind erosion as a major concern in 166 of the 510 reporting locations in these three states. The correlation coefficient between the responses and existing data on wind erosion on cropland was +0.468.

The next two concerns in the first group--food and fiber production and land use--are closely associated. Significant changes in land use recorded over the past few years tend to validate the high level of public concern over food and fiber production and land use changes.

The area devoted to cropland decreased from 438 million acres in 1967 to 413 million acres in 1977. The average annual decrease was 2.5 million acres per year. During the same period, irrigated cropland increased at an average rate of 1.4 million acres per year.

The total pastureland, native pasture, and rangeland increased by 65 million acres from 1967 to 1977. Part of this increase, however, was due to a reclassification of forest land.

Urban, built-up, and transportation land increased at the rate of 1.1 million acres per year from 1958 to 1967. From 1967 to 1977, this conversion rate increased to 2.9 million acres per year. Some of the better agricultural lands are being converted to nonfarm uses. More than one-third of the growth in urban land between 1967 and 1975 took place at the expense of prime farmland.

There are also indications that the acreage of forest land declined substantially between 1967 and 1977. A change in the definition of forest land during this period could account for some of the decline. It appears, however, that considerable land use changes have occurred on nonfederal forest land.

The coefficients in the table at the end of this chapter show a correlation between the public's concern over land use and the changes in land use described above. If the concern over food and fiber production is correlated with concern over urban sprawl, the value is +0.700. If it is correlated with the concern over forestry, the value is +0.550. Therefore, there seems to be significant concern over the loss of land for food and fiber production.

Water supply is the other resource concern in the first group. More than 2,000 people listed it as a major concern. Water supplies can come from either surface or ground sources. There is more ground water in storage than there is available surface water in streams and lakes. In spite of these enormous resources, however, ground water is being withdrawn in excess of recharge at an average rate of about 21 billion gallons per day nationally.

The most significant ground water depletion occurs in the High Plains areas extending from Texas to Nebraska. Central Arizona and parts of California and the lower Mississippi River area also depend heavily on ground water. Public responses indicate that water supply is considered a major resource concern in 80 percent of the 243 counties in the central Great Plains. Responses from Arizona and California show that 81 and 75 percent of the public in those states, respectively, viewed water supply as a major resource concern.

An analysis of responses from 504 selected counties within 11 states shows a relationship between public concern over water supplies and significant overdrafts of ground water. This association is shown in the following tabulation:

State	Number of responses	Number of people listing water supply as a major concern	Number of people listing ground water depletion as a major concern
New Mexico	49	49	34
Mississippi	16	5	5
Arkansas	8	6	5
California	41	40	26
Arizona	16	16	14
Nebraska	34	33	34
Oklahoma	54	47	44
Colorado	50	48	44
Louisiana	35	33	28
Kansas	79	69	52
Texas	122	111	100
Total	504	457	386

Ninety-one percent, or 457 responses, listed water supply as a major concern. Seventy-seven percent, or 386 responses, showed concern over ground water depletion.

The second group, which had a lower number of responses showing public concern, included: water quality; socio-political factors; flooding; irrigation; rural development; prime, unique, and important farmland; drainage; recreation; and forestry. This appraisal does not cover socio-political factors and rural development. Therefore, these concerns were not correlated with existing data.

The first of these concerns--water quality--is widely perceived as a major resource concern. Table 14-1 compares the level of public concern over water quality with existing water problems in selected states. The table covers those states where 60 percent or more of the public's responses showed water quality as a major resource concern.

Table 14-1 indicates that in Arkansas there is considerable concern over water quality (69 percent), yet there are no significant water quality

Table 14-1.--A comparison of the public's concern over water quality and existing water quality problems

State 1/	Percentage of public responses showing a major concern for water quality	Approximate percentage of state's area currently experiencing water quality problems 2/				
		Point source pollution of surface waters	Nonpoint source surface water pollution	Eutrophication	Significant groundwater pollution	Existing or potential pollution of domestic water supply
Iowa	94	30	10	70	30	50
Connecticut	88	50	80	80	80	80
Caribbean Area	78	20	0	100	100	120
New York	77	70	70	70	0	50
Vermont	75	30	70	30	50	10
Kentucky	73	80	80	50	50	10
Louisiana	72	30	50	50	0	50
Minnesota	71	10	5	15	5	50
Arkansas	69	5	0	10	2	15
Maryland	68	50	100	100	0	10
Illinois	67	85	25	60	50	15
Florida	65	15	5	60	40	7
North Carolina	65	25	0	20	18	1
Pennsylvania	64	30	70	15	1	0
Wisconsin	63	60	15	80	5	80

1/ In the states listed, 60 percent or more of the public responses showed concern over water quality.

2/ The Nation's Water Resources. December 1978.

problems. If the table were expanded to include all states where the response was 50 percent or greater, 10 additional states would be added with 3 of them showing the same contradiction that appeared in Arkansas. Conversely, some states that had very low percentages of their responses showing concern over water quality did in fact have potentially serious water quality problems.

These discrepancies indicate an imperfect correlation between public concern and data on the severity of water quality problems. In some states, the public may not be fully aware of the water quality problems.

There were 1,262 responses which indicated that flooding was a major concern. Flooding can be caused by overflow from bodies of water or from soil wetness conditions associated with the depth to the water table.

Existing data show that wetness is a hazard on about 113 million acres of land during part of the growing season (land capability classes IIIw and IVw). Of this acreage, 40 million acres are in cropland. An additional 65 million acres (classes Vw through VIIw) are ponded for a major portion of the year, and 4 million of these acres are used to produce crops. In addition, a high percentage of the flood prone areas identified by the National Resource Inventories in 1977 is in farm production regions where the highest percentage of soils is suitable for cultivation (classes I through III). This appears to indicate a positive relationship between public perception of flooding problems and existing data on flooding. The correlation coefficients that relate data on flooding to the public's concern over soil erosion further indicate this relationship.

In 17 states, 50 percent or more of the responses showed irrigation (water management) as a major concern. Nationwide data indicate that irrigation withdrew about 159 billion gallons of water per day (bgd) from all sources in 1975. Of this amount, 86 bgd were consumed and 73 bgd went into return flow. (Data is for a normalized year "1975", not actual use.)

There are 57.6 million acres of irrigated cropland. An additional 4.8 million acres of pasture are also irrigated. It is estimated that an additional 7 to 17 million acres may be irrigated by the year 2000. Based on the conservative estimate of 7 million more acres of irrigated land, the water consumed would increase from 86 bgd to 105 bgd by the turn of the century. Both the public's responses and existing data indicate that irrigation is a major concern in some areas of the Nation. When the number of responses showing irrigation as a major concern is correlated with the number of acres of land in row crops that would benefit from irrigation management, the coefficient is +0.803. For other cropland, the coefficient is +0.697.

Nationwide, prime, unique, and important farmland ranked tenth in the public's list of 21 major concerns. In 34 state-wide summaries of public responses this concern also ranked tenth or higher.

There are 346 million acres of prime farmland in the United States. The amount by state ranges from a high of 38 million acres in Texas to a low of 81 thousand in Rhode Island. Two-thirds of the prime farmland was cropped

during 1977. Of the 116 million acres not cropped, 42 million acres were in forest, 40 million acres were in native pasture and pastureland, 23 million acres were in range, and 11 million acres were in other uses. Schmude (1977) shows that of the 23 million acres of land converted from rural land to urban, water, and other uses between 1967 and 1975, more than one-third (8 million acres) was prime farmland. These data would appear to substantiate the public's concern over this resource.

There is a close correlation between the number of public responses showing concern over food and fiber production, loss of cropland production acres, forestry, and conversion of prime land to irreversible uses and the data on changes in the acreage of prime farmland shown in the National Resource Inventories. Further, there is a high correlation between the public's major concerns over soil erosion and irreversible loss of prime farmland.

The existing data on flooding validate the public's concern over drainage as a major resource problem.

A table in chapter 6 of this appraisal contains projections of the future demand for outdoor recreation by activity group and type of activity through the year 2030. The base year used in the table was 1977 (1977=100). This table showed that significant increases are expected in a number of recreational activities. The highest index was for sailing (367) and the lowest for pleasure driving (143). The public rated recreation twelfth in its list of major concerns. This would indicate that the public correctly perceived the anticipated growth in recreation and the need to accommodate it.

Forestry was the last concern in the second group (those concerns that were rated as major in 1,000 to 2,000 responses). A number of variables could be related to the public's perception of forestry as a major concern, because the actual use of forest lands is as varied as are the interests of the people who own and manage them.

Overall, it appears that the public's concern over forestry is closely related to its concerns over erosion, food and fiber production, and land use changes. On forest land not grazed, about 20 percent of the acres could benefit from practices involving establishment and reinforcement of the timber stand to resolve soil and water conservation problems. Timber stand improvement in order to increase growth and quality would be beneficial on about 80 percent of the acreage. These data, coupled with the marked decline in forest land acreage, would indicate that the concern over forestry is directly related to the other major concerns previously mentioned and closely correlated with existing data. This opinion is substantiated in all cases by correlation coefficients except in the case of erosion on grazed forest land. While the coefficient values are low in relating the acres that could benefit from improved forage for grazing and less grazing on forest land, other concerns such as food and fiber production are highly correlated.

Wildlife habitat was the first concern in the third group (those concerns that were considered major in fewer than 1,000 responses). The public's perception that this resource is a major concern seems to be related to

several developments. Advancing technology in crop production, land use changes, intensive forestry management, and monoculture have all had negative effects on wildlife habitat.

Advancing technology has increased the efficiency of crop production. At the same time, however, monoculture and increased mechanization have adversely affected wildlife habitat. The result is fewer hedgerows, field borders, grassy areas, woodlots, and other areas of intervening vegetation that are used by wildlife. Where one or two plant species predominate, the land has little value for wildlife. This is true in both pastureland and forest.

Many kinds of wildlife are "edge species" and exist in significant numbers only around openings in the forest and in areas of early forest succession. Forestry management practices geared exclusively to timber production often have an adverse effect on these kinds of wildlife.

The public's concern regarding land disposal of organic waste appears to be related to the potential effect such disposal has on land resources and water quality. Although there are no data from the National Resource Inventories to support this concern, this relationship appears valid when we consider that land use for food and fiber production and water quality are also major concerns.

Food fish and game fish constitute a significant natural resource. This fact is reflected in the public's response concerning fish habitat. The public apparently considers this resource a major concern because of its role in both food production and recreation.

Surface mining directly involves a relatively small area in the United States. The area disturbed by mining as of July 1977 amounted to 5.7 million acres. However, the intense hydrologic and esthetic changes in the environment that result from surface mining affect areas surrounding mined sites.

The states with the greatest area of land disturbed by mining are: Pennsylvania, 621,000 acres; Ohio, 531,000 acres; Kentucky, 421,000 acres; Florida, 332,000 acres; and Illinois, 296,000 acres. The public responses were examined for 107 counties having more than 3,000 acres of land disturbed by surface mining. The following tabulation shows how the public's responses correlate with data on disturbed land:

State	Number of counties	Percentage listing mining as a major concern
Pennsylvania--------	28	79
Ohio----------------	24	67
Kentucky------------	24	96
Florida-------------	13	31
Illinois------------	18	50

Only 430 public responses indicated that environment was a major concern. Sufficient data do not exist to either substantiate or refute a relationship between these responses and data on environmental resources. Subjectively, it may be concluded that there is more concern for environment than shown by the major responses because the number of responses indicating that environment was a minor concern was rather high--1,927.

The general character of the term "environment" also makes it impossible to mathematically correlate the public's responses with existing sets of data, all of which are more specifically focused. The term "environment" is rather general and includes many facets of the concerns that the public often considered major, for example, soil erosion and water quality.

The responses regarding wetlands correlated significantly with data on the loss of wetlands. During recent years large amounts of wetlands have been lost or degraded. Although wetlands are generally recognized as contributing a considerable benefit to the environment, this resource ranked next to last among major concerns. The minor concern of wetland loss, when correlated with acres of wetland from the National Resource Inventories, has a correlation coefficient of +0.619. Degradation of wetlands has a correlation coefficient of +0.637. These values relate to land used for row crops.

U.S. Fish and Wildlife Service Circular 39, "Wetlands of the United States," (Shaw and Fredine, 1956) identifies waterfowl flyways that contain large amounts of valuable wetlands. Several of these areas coincide to a degree with certain SCS Major Land Resource Areas (MLRA's) (Austin, 1972). The responses in the following tabulation are from all locations within these MLRA's.

Flyway Area/MLRA	Number of responses	Percentage showing wetlands as a major concern
Mississippi North		
Northern Minnesota Swamps and lakes	12	25
Central Wisconsin and Minnesota Thin Loess and Till	26	27
Wisconsin and Minnesota Sandy Outwash	9	11
Northern Michigan and Wisconsin Stony, Sandy, and Rocky Plains and Hills	23	17
Northern Michigan Sandy Drift	27	41
Mississippi South		
Southern Mississippi Valley Alluvium	53	30
Eastern Arkansas Prairies	2	0
Atlantic South		
Gulf Coast Prairies	21	5
Gulf Coast Marsh	6	50
Gulf Coast Flatwoods	9	22
Atlantic Coast Flatwoods	79	16

Three hundred public responses showed that air quality is a major concern. Again, as in the case of environment, there are not sufficient data to show a correlation with the responses. The public may have expressed its concern over air quality by listing related concerns such as wind erosion as major. For example, Colorado has a high rate of wind erosion, and it was the only state within the conterminous boundaries of the United States where more than 25 percent of the public responses showed air quality as a major concern.

Table 14-2.--Correlation coefficients relating resource concerns to resource data
(Probability level is 0.0001 for all correlation coefficients)

Resource data by land use 1/	Resource concerns 2/										
	LU101	CP103	FL301	IRR602	WAE802	CPE803	WA603	WIE818	WICP819	FOR1401	REF1406
Row cropland:											
NEC ------------	---	---	---	---	.593	.594	---	---	---	---	---
NIRRM-----------	.697	---	---	.803	---	---	---	---	---	---	---
PRIME-----------	---	.669	---	---	---	.613	---	---	---	---	---
FLDPRN----------	---	---	.614	---	---	---	---	---	---	---	---
Other cropland:											
NEC-------------	---	---	---	---	---	---	---	.721	.703	---	---
NIRRM-----------	---	---	---	.697	---	---	.690	---	---	---	---
Forest land:											
NESTT-----------	---	---	---	---	---	---	---	---	---	.763	.796
LOWPOT----------	---	---	---	---	---	---	---	---	---	---	.622
MEDPOT----------	---	---	---	---	---	---	---	---	---	.791	.899
HIPOT-----------	---	---	---	---	---	---	---	---	---	.781	.839

Footnotes for table 14-2

Resource Data 1/

NEC	Amount of land needing erosion control
NIRRM	Amount of land needing irrigation management
PRIME	Amount of prime farmland
FLDPRN	Amount of flood prone land
NESTT	Amount of ungrazed forest land needing establishment and reinforcement of timber
LOWPOT	Amount of noncropland that is unlikely to be converted to cropland
MEDPOT	Amount of noncropland that is likely to be converted to cropland
HIPOT	Amount of noncropland that is very likely to be converted to cropland

Resource Concerns 2/

LU101	Food and fiber production
CP103	Loss of cropland as it affects food and fiber production
FL301	Flooding
IRR602	Irrigation water management
WAE802	Soil erosion - water
CPE803	Soil erosion - water - in cropland
WA603	Water availability for irrigation
WIE818	Soil erosion - wind
WICP819	Soil erosion - wind - in cropland
FOR1401	Forestry on nonfederal land
REF1406	Forestry on nonfederal land and need for reforestation

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Glossary

Accelerated erosion. Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a natural catastrophe, for example, fire, that exposes the surface.

Activity occasion (recreation). Participation by one person in one activity in one day without regard to the duration of such participation.

Animal unit month (AUM). A measure of forage or feed required to maintain one animal unit--one cow, one horse, one mule, five sheep, five swine, or six goats--for a period of 30 days.

Aquaculture. Propagation and rearing of aquatic species in controlled or selected environment.

Area mining. Mining of large areas of flat-lying beds under relatively shallow overburden. Overburden is removed in many successive cuts.

Available water capacity (water holding capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Biomass. (1) The total amount of living material in a particular habitat or area. (2) An expression of the total weight of a given populaton of organisms.

Biota. The flora and fauna of a region.

Bituminous coal. A soft coal that is high in carbonaceous matter and is 15 to 50 percent volatile matter. The volatile matter consists of those products, exclusive of moisture, given off by a material, for example, gas and vapor. Products are determined by definite described methods that may vary according to the nature of the material.

Carrying capacity (recreation). The amount of use a recreation area can sustain without deterioration of its quality.

Cellulosic waste. Byproducts from the processing of wood and other vegetative material.

Clearcutting. A method of cutting that removes the entire timber stand from the area cut.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Commercial forest land. Forest land that is utilized for timber and produces, or is capable of producing under management, in excess of 20 cubic feet per acre per year of industrial wood.

Conservation tillage. A form of noninversion tillage that retains a protective amount of residue mulch on the surface throughout the year. (Some conservation tillage methods are: minimum tillage, no till, reduced tillage, stubble-mulch tillage, chisel planting, and till planting.)

Contour farming. Plowing, planting, cultivating, and harvesting on the contour.

Contour mining. Mining of coal on hillsides in hilly or mountainous areas. Overburden is removed in one or several cuts by equipment following the coal outcrop along the natural contour of the surface of the ground.

Conventional tillage. The combined primary and secondary tillage operations normally performed in preparing a seedbed for a given crop. Depending on geography, rainfall, and soil, they may include plowing, disking, and harrowing.

Cover crop. A close-growing crop grown primarily for the purpose of protecting and improving soil between periods of regular crop production or between trees and vines in orchards and vineyards.

Cropland. Land used primarily for the production of cultivated crops, close-growing crops, and fruit and nut crops.

Crop residue. The part of a plant or crop left in the field after harvest.

Dike. An embankment that confines or controls water, especially one built along the banks of a river to prevent overflow of lowlands; a levee.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Ecosystem. A community, including all the component organisms, together with the environment, forming an interlacing system.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and through such processes as gravitational creep.

Eutrophication. A process through which a body of water ages. Nourished aquatic plants--often algae--in waters enriched with nutrients and organic matter cause the water body to become shallower and deplete oxygen supplies seasonally.

Evapotranspiration. The combined loss of water from a given area and during a specific period of time by evaporation from the soil surface and by transpiration from plants.

Farmstead and feedlot windbreaks. A belt of trees or shrubs established next to a farmstead or feedlot to protect soil resources, control snow deposition, prevent wind damage to farmsteads, provide shelter for livestock, beautify an area, or improve an area for wildlife.

Federal forest land. Land, under federal ownership, at least 10 percent stocked by forest trees of any size, including land that formerly had tree cover and is not currently developed for nonforest use.

Federal land. All land and small areas of water owned and managed by federal agencies, for example, national forest, national parks, military reservations, public domain lands, and national grasslands.

Field windbreaks. A strip or belt of trees or shrubs established in or adjacent to a field to reduce soil blowing, control snow deposition, conserve moisture, protect crops and orchards, provide shelter for livestock and wildlife, or increase the natural beauty of an area.

Flood prone areas. Areas adjoining rivers, streams, watercourses, bays, lakes, alluvial plains, or other areas that in the past have been covered intermittently with flood water or that can be expected to be flooded in the future. Areas subject to inundation by a flood having an average recurrence interval of once in 100 years, or a 1 percent chance of occurrence in any given year.

Fluvial habitat. Habitat provided by streams or ponds.

Forest cover types. Category of forest defined by its vegetation, particularly in terms of composition or location.

Fossil fuel. Coal, petroleum, and natural gas.

Grade stabilization structure. A structure that stabilizes the grade of a gully or other watercourse, thereby preventing further head cutting or lowering of the channel grade.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravitational water. Water that moves into the soil, through the soil, or out of the soil under the influence of gravity.

Green manure crop. A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground-water mining. Overdraft: water withdrawn from the ground at a rate greater than the long term rate of recharge.

Hardpan. A hardened or cemented soil layer. The sandy, loamy, or clayey soil material is cemented by iron oxide, silica, calcium carbonate, or other substances. The hardness does not change appreciably with changes in moisture content, and pieces of the hard layer do not slake in water.

High-sulphur coal. Coal that is more than 2 percent sulphur, by weight.

Hydrologic changes. Changes that relate to water standing or flowing on or beneath the surface of the earth.

Hydrologic values. The worth of wetlands as related to water retention or storage.

Hydrophyte. A plant that grows in water or is partially immersed in water at all times.

Irrigation water management. The use and management of irrigation water whereby the quantity of water used for each irrigation is determined by the water-holding capacity of the soil and the need of the crop. The water is applied at a rate and in such a manner that the crop can use it efficiently and no significant erosion occurs.

Land capability. The quality of soil resources for agricultural use is commonly expressed as land capability classes and subclasses, which show, in a general way, the suitability of soils for most kinds of field crops. Soils are grouped according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.
Class II soils have moderate limitations that reduce the choice of plants.
Class III soils have severe limitations that reduce the choice of plants.
Class IV soils have very severe limitations that reduce the choice of plants.
Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.
Class VI soils have severe limitations that make them generally unsuitable for cultivation.
Class VII soils have very severe limitations that make them unsuitable for cultivation.
Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, "e," "w," "s," or "c," to the class numeral, for example, IIe. The letter "e" shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; "w" shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); "s" shows that the soil is limited mainly because it is shallow, droughty, or stony; and "c," used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

Leachates. Liquids that have percolated through a soil and that contain substances in solution or suspension.

Lentic. Pertaining to standing (nonflowing) waters such as lakes, ponds, and swamps. See lotic.

Lignite. A brownish-black coal in which the alteration of vegetal material has proceeded farther than in peat but not so far as in subbituminous coal. Lignite is coal of low rank with high inherent moisture and volatile matter.

Loess. Fine grained material, predominantly silt-sized particles, transported and deposited by wind.

Lotic. Pertaining to flowing waters such as streams and rivers. See lentic.

Low-sulphur coal. Coal that is less than 1 percent sulphur, by weight.

Macrohydrophyte. Any plant that grows in water and that can be seen with the unaided eye. Aquatic mosses, ferns, liverworts, or rooted plants are examples.

Microorganisms. Those organisms retained on a U.S. standard sieve no. 100 (openings of 0.149 mm); those minute organisms invisible or only barely visible to the unaided eye.

Minimum tillage. Limiting the number of cultural operations to those that are properly timed and essential to produce a crop and prevent soil damage.

Monoculture. Raising crops of a single plant variety, cultivated as well as natural.

Mulch. A natural or artificial layer of plant residue or other material on the soil surface.

Native pasture. Land on which the natural potential plant community is forest, but which is used and managed mainly for the production of native grasses for forage.

Nitrification. The biological oxidation of ammonium to nitrite and the further oxidation from nitrite to nitrate.

Nonfederal forest land. Land that is mainly under private ownership but that also includes state and municipal land. It is defined as land under at least a 25 percent tree canopy cover or land at least 10 percent stocked with forest trees of any size, including land formerly forested that will be naturally or artificially reforested. It does not include transition zones between heavily forested and nonforested land that can also be defined as rangeland, nor does it include forested areas that can be defined as urban and built-up land.

Nonfederal land. All land and associated small water bodies owned by state or local governments, individuals, corporations, or other entities.

Open pit mining. Examples of open pit mines are quarries producing limestone, sandstone, marble, and granite; sand and gravel pits; and large excavations opened to produce commodities such as iron and copper. Usually in open pit mining, the amount of overburden removed is proportionately small compared with the quantity of ore or coal recovered.

Overburden. Soil and rock material overlying the coalbed.

Pastureland. Land used primarily for the production of domesticated forage plants for livestock. This land does not include rotation pasture or cropland under winter cover crops.

Pathogen. An organism capable of producing disease.

Periphyton. Microscopic organisms attached to and growing on the bottom of a waterway or on submerged objects. Also called aufwuchs.

Phreatic line. The line marking the upper surface of the zone of water saturation in the soil.

Phreatophyte. Plant dependent on ground water as opposed to soil moisture, (for example, willow, cottonwood, greasewood, and saltcedar).

Prime farmland. Land that is best suited to the production of food, feed, forage, fiber, and oilseed crops and that is also available for those uses. It can be cropland, pastureland, rangeland, forest land, or other land. It has the soil quality, growing season, and moisture needed to produce sustained high yields of crops economically if managed according to acceptable farm practices. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources and does so with the least damage to the environment.

Profile soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range condition. The present composition of the plant community on a range site as related to the potential natural plant community for that site Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the natural potential (climax) plant cover is principally native grasses, grasslike plants, forbs, and shrubs. It includes natural grasslands, savannahs, certain shrubs and forb lands, most deserts, tundra, alpine communities, coastal marshlands, and wet meadows. It also includes lands that are revegetated naturally or artificially and are managed like native vegetation. Except for brush control, rangeland is managed primarily by regulating grazing and protecting the plant cover. It is not cultivated, drained, irrigated, or mechanically harvested.

Rill erosion. An erosion process through which numerous small channels a few inches deep are formed by surface runoff. Rill erosion occurs mainly on recently cultivated soils.

Riparian habitat. Habitat related to or located along a watercourse.

Savannah. Grassland with scattered trees, either as individuals or clumps; often a transitional type between true grassland and forest.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Short tons. A unit of weight that equals 20 short hundredweights or 2,000 avoirdupois pounds. Used chiefly in the United States, Canada, and the Republic of South Africa.

Silviculture. The art and science of cultivating, that is growing and tending, forest crops according to a knowledge of silvics. The theory and practice of controlling the establishment, composition, and growth of forest.

Soil deterioration. Loss of potential productive capacity of a soil that results from destructive processes accelerated by the activities of man, for example, through soil erosion and waterlogging.

Soil moisture zone. Depth of soil from which plant roots extract water.

Soil order. Ten orders are recognized. The properties used to differentiate among orders are those that reflect the kind and degree of soil forming processes that have taken place. Each order is identified by a word ending in sol. An example is Mollisol.

Soil suborder. Each soil order is divided into suborders based primarily on properties that influence soil genesis and that are important to plant growth, or that were selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll--Aqui, meaning water, plus oll, from Mollisol.

Statewide comprehensive outdoor recreation plan (SCORP). A guide to outdoor recreation actions focusing on needs, trends, problems, and policies and encompassing all outdoor recreation activities, resources, and programs that are significant in providing outdoor recreation opportunities within a state.

Stripcropping. Growing crops in a systematic arrangement of strips or bands that serve as barriers to wind and water erosion.

Strippable reserves. The recoverable strippable coal resources adjusted to conform to the stripping ratio, which varies by area. Coal that cannot be mined because of the proximity of natural or manmade features is also excluded. These reserves are the actual raw tons of coal that can be removed from the ground. They are also assumed to be all "available" tonnages and are not divided into "measure," "indicated," and "inferred" reserves.

Strip tillage. Planting and tillage operations that are limited to a strip not to exceed one-third of the distance between rows; leaving the area between untilled with a protective cover of crop residue on the surface for erosion control.

Stubble-mulching. Leaving the stubble of crops or crop residue essentially in place on the land as a surface cover during fallow and the growing of a succeeding crop.

10-year - 7-day low flood (streamflow). The least volume of flow in a 7-day period that can be expected in the next 10 years. A commonly used low-flow standard.

Terrace. (1) An embankment, or ridge, constructed across sloping soils on the contour or at a right angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod. (2) A level, usually narrow plain bordering a river, lake, or sea. Rivers sometimes are bordered by terraces at different levels.

Toxic salt reduction. Decreasing harmful concentrations of toxic salts in soils, usually by leaching and with or without the addition of soil amendments.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron in soils in extremely small amounts.

Tundra. A level to undulating treeless plain characteristic of arctic and subarctic regions. It has a permanently frozen subsoil and supports a vegetation consisting mainly of tufted, low cushionlike sedges, grasses, lichens, and mosses with forbs and dwarf shrubs on drier sites. Tundra occurs along southwestern coastal areas, on exposed ridges, and on all mountain ranges in Alaska.

Turbidity. (1) The cloudy condition caused by suspended solids in a liquid. (2) A measurement of the suspended solids in a liquid.

Urban and built-up areas. Cities, villages, other built-up areas of more than 10 acres, industrial sites, railroad yards, cemeteries, airports, golf courses, shooting ranges, institutional and public administration sites, and similar areas.

Visit (recreation visit). A visit by one individual to a recreation development or area for recreation purposes during a reasonable part or all of a 24-hour period.

Water-depletion. Water that is consumed and irrecoverable to the immediate hydrologic system. Evapotranspired because of man's activity.

Wilderness. A large, generally inaccessible area left in its natural state and available for recreation. It is void of development except for those trails, sites, and similar alterations made by previous wilderness users.

Wind erosion. The detachment and transportation of soil by wind.